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NET ZERO EMISSIONS AND SUSTAINABLE DEVELOPMENT IN VIETNAM AND TAIWAN (CHINA)

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"Capacity Building in Training and Research on Low-Carbon Economy in the context of Climate Change for the National Economics University in Vietnam in partnership with Universities and Research Institutes in Taiwan"

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Net Zero Emissions and Sustainable Development in Vietnam and Taiwan (China)

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Net Zero Emissions and Sustainable Development in Vietnam and Taiwan (China)

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SECTION I

CLIMATE CHANGE AND NET ZERO EMISSIONS

The Effects of Economic Factors on CO_2 Emissions in the Moderating Role of Renewable Energy: An Empirical Evidence in Asean Countries

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Abstract

This study investigates the economic factors affecting carbon emissions in ASEAN countries and the moderating role of renewable energy use in these countries from 2001 to 2020 by the Mixed-effects ML regressions. The results show that economic growth in ASEAN countries can lead to higher CO_2 emissions while using renewable energy significantly reduces CO_2 emissions in these countries. The moderating role in the impact relationship of economic growth on CO_2 emissions has been mitigated by the impact of renewable energy. Similarly, the moderating role of renewable energy also contributes significantly to reducing emissions when considering the effects of foreign direct investment. The study is significant for future analysis of emissions in countries regarding the impact of economic factors on CO_2 emissions with the moderating role of renewable energy.

Keywords: *CO_2 emissions, economic growth, trade openness, foreign direct investment.*

1. Introduction

In 1992, in Rio de Janeiro, the Conference on Environment and Development by the United Nations (UNCED) reaffirmed sustainable development and sent a clear message to all levels of government about the urgency of promoting economic and social development in harmony with environmental protection (UN, 1992). Recent studies highlight the correlation between rapid economic growth and increased consumption of fossil fuels, leading to significant CO_2 emissions (He et al., 2020; Jebabli et al., 2023). Achieving economic development with the environment and sustainability is considered an essential goal in the policies of governments worldwide. In addition, globalization is an international phenomenon impacting people's lives worldwide in terms of economics and socio-politics. Globalization connects the world's economies through trade and foreign direct investment. He et al. (2020) argue that globalization is linked to worldwide trade liberalization, financial development, economic growth, and environmental quality. Countries pursue maximum economic growth through foreign trade and investment, primarily driven by industrialization and urbanization, leading to environmental degradation. This degradation is primarily due to the increased reliance on traditional energy sources for economic activities, such as industrial production. In such cases, efforts to reduce CO_2 emissions could adversely affect economic growth, a consequence many countries are reluctant to face.

The Asian Development Bank (ADB), in collaboration with the ASEAN Catalytic Green Finance Facility (ACGF), organized the Southeast Asia Development Solutions (SEAD) Workshop 2023 with the theme "Imagining a Net-Zero ASEAN" in Bali, ASEAN countries are currently striving to achieve net-zero emissions by 2050. However, their strategies have encountered certain limitations (Asian Development Bank, 2023). According to a report by Bain & Company, GenZero, Standard Chartered, and Temasek Southeast (2024) through “Asia’s Green Economy 2024 Report: Moving the needle”, Southeast Asia needs to cut carbon dioxide emissions by at least 45% by 2030. The report also highlights that Southeast Asia still emits 3 million tons of carbon dioxide annually from approximately 647 million cars on the road, making achieving the 2030 target a distant goal. Some countries' investment strategies to reduce carbon emissions have also been ineffective. Current investments are less than USD 20 million, falling short of the required USD 1-3 trillion to reduce carbon emissions effectively. The report suggests that investments need to increase 15-20 times by 2030.

Furthermore, policies to reduce fossil fuel dependency in some countries in the region have yet to yield the desired results. Indonesia, for example, will impose a coal tax in July 2022. However, with a projected rate of 30,000 rupiahs, the report predicts Indonesia will not achieve the desired outcome. Another challenge for some Southeast Asian countries in addressing climate change is rapid urbanization in coastal areas, making environmental protection difficult. Many scientists believe that the population in coastal areas is increasing, particularly in Thailand and the Philippines, where rapid coastal urbanization threatens the environment and hinders climate change mitigation efforts.

Recent studies have shown great interest in the economic factors affecting CO_2 emissions. However, the results still need to be clarified, especially in ASEAN countries; besides, the moderating role of renewable energy in the above impacts has yet to reach a full conclusion. This study is expected to contribute to the issue of emissions related to economic factors and the moderating role of renewable energy.

2. Literature review

Despite the vital link between economic growth and green growth, research still needs to be conducted. Given the sparse literature on this topic, we review studies that, while potentially differing in focus, are connected to environmental issues and their impact on economic growth. Ahmed & Ahmed (2018) research on data in China shows that the CO_2 emission situation is becoming increasingly severe. The authors emphasize that the GDP factor harms CO_2 emissions in this country, while strict environmental policies can reduce emissions. Similarly, Rahman et al. (2023) found that while the short-term effects of GDP and population on South Asian countries are positive but insignificant, GDP becomes significant in the long run.

Additionally, renewable and nuclear energy are crucial in reducing pollution in these countries. In contrast, Zhang and Zhang (2018) studied the EKC curve with data in China; the results showed that trade openness harms CO_2 emissions, while foreign direct investment positively impacts emissions. Meanwhile, using Bangladesh data, Islam et al. (2023) concluded that globalization, foreign direct investment, and innovation contribute to reducing CO_2 emissions and improving environmental quality. Meanwhile, trade openness, economic growth, and energy consumption positively impact CO_2 emissions, leading to short- and long-term environmental degradation.

Several studies have shown that high energy consumption is associated with worse environmental quality (Shahzad, 2020; Khan et al., 2021). Saidi and Omri (2020) argue that countries need to promote and increase the use of renewable energy in production to avoid economic harm to the environment. Meanwhile, Jebli and Youssef (2017) suggest that renewable energy consumption could potentially increase CO_2 emissions, as specific renewable sources, like biomass and waste, can be highly pollution-intensive. Therefore, a fully integrated renewable energy system may decrease carbon emissions effectively (Pata, 2018). Kahouli (2018) also reports that higher renewable energy consumption might boost energy-intensive economic activities. Pata and Samour (2023) recommend that OECD countries focus on policies that promote renewable energy use rather than incentivizing the insurance market.

Many studies have focused on economic factors for the effects on CO_2 emissions; while this relationship is still quite complicated, the using of fossil energy or renewable energy is still controversial; at the same time, the use of renewable energy can reduce the impact of economic factors on CO_2 emissions, just like the using of green energy reduces the negative impact on the environment, at the same time the aggregate data for ASEAN countries to verify this relationship, especially for the moderating role of renewable energy has not been fully concluded, this study hopes to find convincing answers to the above problem. Studies have shown a complex relationship between economic factors, particularly economic growth, foreign direct investment attraction, trade openness, or the use of renewable energy, and CO_2 emissions. There is still much debate on this issue. Based on these findings, the authors propose the following research model:

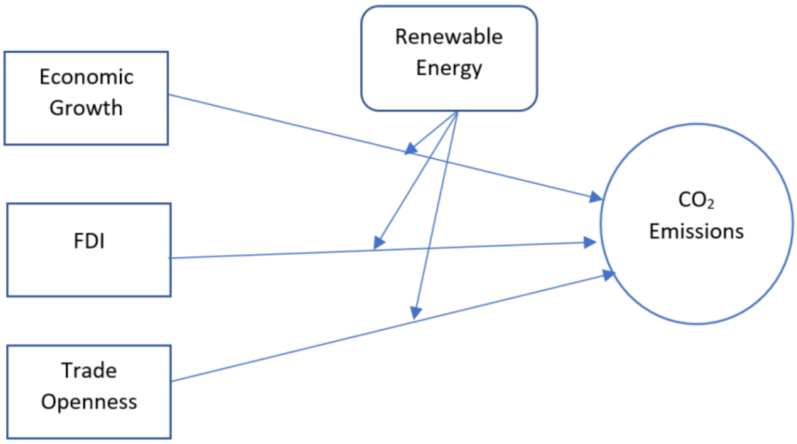

Figure 1: Research model

Source: Compiled by the authors

The model proposes that CO_2 emissions are influenced by economic growth, foreign direct investment net inflows, trade openness, and the moderating role of renewable energy. It suggests that renewable energy adoption can mitigate emissions through economic factors such as economic growth, foreign direct investment net inflows, and trade openness.

3. Methods

Building on previous research (Ahmed & Ahmed, 2018; Zhang & Zhang, 2018; Jebli & Youssef, 2017; Islam et al., 2023), this study analyzes data from 10 ASEAN countries spanning 2001 to 2020. The annual data was sourced from the World Bank, and the moderating role of renewable energy use in these countries during the same period is examined using Mixed-effects Maximum Likelihood regressions. The authors propose the following econometric model:

$$\text{Carbon emissions}_{it} = a + \beta 1.\ (GDP_{it}.REN_{it}) + \beta 2.\ (TRADE_{it}.REN_{it}) + \beta 3.\ (FDI_{it}.REN_{it}) + u_i$$

Where: Carbon emissions CO_2 denotes carbon dioxide emissions (tons); GRO stands for the GDP growth (%); FDI represents foreign direct investment net inflows ($million); TRADE denotes trade openness (%); REN represents renewable energy (%).

4. Results

The research results include descriptive statistics, correlation matrix tests, necessary tests, and regression results, including a mixed-effects model (Model 1) and mixed-effects regression with the moderating role of renewable energy (Model 2).

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CO_2	200	120.758	139.8459	.99781	605.2906
GRO	200	5.182678	3.724358	-9.518295	14.51975
FDI	200	-3938.728	8701.933	-58083.1	23543.53
TRADE	200	133.7727	86.43294	32.97218	437.3267
REN	200	33.555	27.57672	0	85.5
Notes: CO_2 denotes carbon dioxide emissions (tons); GRO stands for the GDP growth (%); FDI represents foreign direct investment net inflows ($million); TRADE denotes the trade openness (%); REN represents the renewable energy (%).					

Source: Compiled by the authors

The descriptive statistics show that CO_2, FDI, and TRADE have relatively high standard deviations (139.8459, 8701.933, and 86.43294, respectively), indicating a wide range of values. GRO has a moderate standard deviation (3.724358). The average values of CO_2 (120.758) and TRADE (133.7727) are positive, while the average value of FDI (-3938.728) is negative. Descriptive statistics, such as minimum and maximum values, offer valuable insights into a dataset's range and distribution of data points. For instance, examining the variable CO_2 reveals a minimum value of 0.99781 in Lao PDR in 2001 and a maximum value of 605.2906 in Indonesia in 2019.

Similarly, FDI net inflows range from -58083.1 in Singapore in 2018 to 23543.53 in Thailand in 2020. Additionally, the variable GRO demonstrated a minimum of -9.51829 in the Philippines in 2020 and a maximum of 14.51975 in Singapore in 2010. Furthermore, TRADE values span from 32.97218 in Indonesia in 2010 to 437.3267 in Singapore in 2008. Finally, the variable REN ranges from 0 in Brunei Darussalam to 85.5 in Myanmar in 2009.

Table 2: Collinearity Matrix

	CO_2	GRO	FDI	TRADE	REN
CO_2	1.0000				
GDP	-0.1312	1.0000			
FDI	-0.1530	-0.0129	1.0000		
TRADE	-0.2521	0.0354	-0.4430	1.0000	
REN	-0.2726	0.5176	0.2450	-0.4017	1.0000

Note: CO_2 denotes carbon dioxide emissions (tons); GRO stands for the GDP growth (%); FDI represents foreign direct investment net inflows ($million); TRADE denotes the trade openness (%); REN represents the renewable energy (%).

Source: Compiled by the authors

The correlation coefficients of the variables are negligible when their values are all less than 0.7, showing that the variables do not have perfect multicollinearity and are suitable for inclusion in the analysis model.

Table 3: The results of the economic factor's impact on CO_2 emissions in the moderating role of renewable energy in ASEAN

	Model 1	Model 2
	CO_2	CO_2
GRO	5.868*	9.175**
TRADE	-0.961***	-0.634***
FDI	-0.00460***	-0.000405
REN	-2.647***	-1.516
c.REN#c.GDP		-0.188*
c.REN#c.FDI		-0.000400***
c.REN#c.TRADE		0.000425
Cons	289.6***	218.9***
N	200	200

Note: * p<0.05, ** p<0.01, *** p<0.001. *CO_2 denotes carbon dioxide emissions (tons); GRO stands for GDP growth (%); FDI represents foreign direct investment net inflows ($million); TRADE denotes trade openness (%); REN represents renewable energy (%).*

Source: Compiled by the authors

Regression model results, including a mixed-effects model (Model 1) and mixed regression with moderation (Model 2). This regression analysis is a mixed-effects model using maximum likelihood estimation (ML). It investigates the relationship between a dependent variable CO_2 carbon emissions) and several independent variables, including renewable energy (REN), GDP growth (GRO), foreign direct investment net inflows (FDI), and trade openness (TRADE). The model includes both fixed effects (representing the average effect of the independent variables on the dependent variable) and random effects (capturing the variation in the relationship across different groups or individuals).

The results are presented in Table 3. Renewable energy contributed to decreasing carbon dioxide emission, with an average decrease in the carbon dioxide emission of 1.5159 tons when the rate of renewable energy increases by 1 percent, which indicated a similar impact in the previous studies (Rahman et al., 2023; Pata & Samour, 2023).

In Table 3, the results show that the GRO variable shows statistical significance and positively affects the carbon dioxide emission in the ASEAN countries; when the GDP growth increases by 1%, carbon dioxide is 9.1746 tons. Similar results are documented in the previous studies (Ahmed & Ahmed, 2018; Islam et al., 2023), indicating a positive influence of economic growth on CO_2 emissions in these countries. Meanwhile, global trade and investment tend to reduce CO_2 emissions. As countries gain access to and adopt advanced technology, deep globalization has driven a more prominent need for emissions reductions in ASEAN countries.

In particular, the moderating effect of renewable energy on the relationship between economic growth and foreign direct investment is that it reduces the impact of economic factors on emissions. Meanwhile, the moderating role of renewable energy led to a downward trend of 0.188 tons and 0.0004 tons, respectively. These results also align with the previous studies (Pata & Samour, 2023), but it is different from other studies (Jebli & Youssef, 2017; Saidi & Omri, 2020) due to some reasons, such as the scope and object of research.

5. Conclusion

Policy implications have emerged based on the findings of this study. Firstly, our findings indicate that renewable energy in ASEAN harms carbon dioxide emissions, which helps to increase the environmental quality in these countries. Meanwhile, economic growth leads to an increase in CO_2 emissions, so we should consider carefully the trade-off between the benefit of the economy and the environmental quality for our likelihood in the future. Secondly, by using renewable energy, production activities support the gradual decrease of the effects of economic factors on emissions.

Furthermore, the results suggest that promoting renewable energy significantly reduces the impact of economic growth and foreign direct investment inflows on CO_2 emissions in ASEAN, which should pay attention to the emission problems and boost the rate of renewable energy in the economy. Transitioning to renewable energy lessens dependence on finite fossil fuels, stabilizes energy prices, and enhances energy security. As an infinite resource, renewables safeguard the environment and support sustainable development for future generations.

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The Influence of Global Value Chains Position on Carbon Emissions in Selected Asia-Pacific Countries from 1995 to 2020

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Abstract

The Asia-Pacific region accounts for two-thirds of the world's population and nearly half of global trade. It is also home to economies that hold key positions in the Global Value Chains (GVCs). On the other hand, this region is responsible for more than half of the world's CO_2 emissions. Therefore, studying the impact of a country's position in the GVCs is of significant importance. This study calculates the position index in the GVCs using OECD data for 22 selected countries in the Asia-Pacific region. The findings indicate that upstream movement in the value chains of these countries has a positive impact on CO_2 emissions. This result implies that deeper integration into the GVCs corresponds to a shift towards carbon-intensive industries, which demand higher energy and fuel consumption, thus resulting in greater CO_2 emissions.

Keywords: *Asia - Pacific, carbon emissions, Global Value Chains position*

1. Introduction

In early 2024, Venezuela's last glacier, Humboldt, disappeared, making Venezuela the first country to lose all of its glaciers in modern times (Ramírez et al., 2020) The glacier's accelerated melting, which is occurring faster than previously anticipated and was projected to continue for at least another decade, highlights the severe impact of carbon emissions in accelerating global warming. According to a report by the Intergovernmental Panel on Climate Change (IPCC, 2022), global CO_2 emissions have surged dramatically, increasing from approximately 23 billion tons in the 1990s to 37 billion tons by 2021. These emissions have contributed significantly to global warming, which is expected to have severe consequences for life on Earth. In this context, more than half of global carbon emissions originate from Asia-Pacific countries (IEA, 2021). The direct impacts on humans include effects on health, food production, access to freshwater, oceanic food chains, productivity, and the destruction of critical infrastructure. These effects are likely to displace communities and force migration. Furthermore, climate change holds the potential to weaken political, economic, and social systems, exacerbating the risk of conflict within and across nations (ADB, 2024).

The period from the 1990s onwards saw an unprecedented surge in global trade, during which GVCs emerged as a new form of trade characterized by the fragmentation of production across borders (Zhang et al., 2017). GVCs quickly accounted for 48% of global trade volume (World Bank, 2021). The World Trade Organization (WTO) emphasized that the label "Made in the World" is becoming more common in place of the traditional "Made in" label, which signifies production in a single country (WTO, 2011). Countries in the Asia-Pacific region have played diverse roles in GVCs, contributing value-added in different segments of production. For example, nations such as Taiwan, South Korea, and Japan have specialized in high-tech components, while countries like Vietnam and China have become known for lower-value-added tasks like assembly and processing (UNCTAD, 2018). The increasing participation of these countries in international trade and GVCs, coupled with the parallel rise in global carbon emissions, raises questions about whether deeper integration into GVCs, particularly moving upstream in the value chains, is linked to carbon emissions.

Research on GVCs suggests that their environmental impact stems from the relationship between international trade and CO_2 emissions. The environmental consequences of GVCs also vary across and between countries. In the literature, there is no consensus between GVCs participation and environmental pollution.

Some studies find that GVCs participation has deleterious effects on the environment environment (Fei et al., 2020; Guedidi & Baghdadi, 2020; Zhang et al., 2021; Ali et al., 2024). Ali et al. (2024) analysed the effect of GVCs participation (GVCP) on CO_2 emissions using panel data estimation techniques for 112 countries over the period 1990–2018. Findings showed that the GVCP contributes to environmental degradation. By contrast, Fei et al. (2020) using the Multi-Regional Input Output (MRIO) and World Input–Output Database (WIOD) model, revealed that intermediate products trade and deepening of the GVCP are positive and highly correlated with carbon emissions in China. Meanwhile, Wu, Hou and Xin (2020) employed a Panel Vector Autoregressive (PVAR) model to examine the causality between GVCs participation and CO_2 emission and found that participation in GVCs had a positive impact on carbon emissions in a sample of 172 countries in the Asia-Pacific region. The CO_2 emissions on average increase by three percent with a one percent increase in GVCs participation.

Meanwhile, a stratum of the literature (Assamoi et al., 2020; Yao et al., 2021; Wang et al., 2022) found that GVCs participation had positive environmental effects as it has brought greener technologies and inputs to countries where the production has taken place, and this lead to reductions of carbon emissions. Yao et al. (2021) posited that countries with high GVCs are more energy-efficient and able to manufacture products with fewer energy inputs, and hence cause fewer emissions. Wang et al. (2022) analyzed these relationships and the underlying mechanisms using a panel vector autoregressive model approach with data for 63 countries and regions from 2005 to 2015. They further argued that participation in GVCs trade contributed to reducing emissions per capita in the long run, but the positive effect was even less pronounced in low-income countries. Meanwhile, Assamoi et al. (2020) studied the effect of Asian countries' participation in GVCs on CO_2 emissions and suggested that participation in GVCs reduced CO_2 emissions in Asian countries.

The effects of GVCs participation on the environment vary across countries. Prior research indicated the empirical evidence of the pollution haven hypothesis, which pointed out that GVCs participation has more significant adverse impacts on carbon emissions intensity in developing economies, or "the South," than in developed countries, "the North." (Zhang et al., 2021; Jithin & Sania, 2023). Jiang & Green (2017) and Basques et al. (2021) argued that developed countries like Japan and South Korea take on cleaner production segments while developing countries such as China, Indonesia, and Malaysia take on more pollution-intensive segments. As a result, GVCs participation by these developed countries significantly reduces CO_2 emissions, while in developing economies it substantially induces CO_2 emissions intensities (Jin et al., 2022). Moreover, Jithin & Sania (2023), also investigated the impact of GVCs participation on CO_2 emissions in 61 economies using OECD data from 2000 to 2018. They found that GVCs participation in developing economies leads to higher CO_2 emissions.

Besides, there are some articles revealing non-linear relationships between GVCs participation and CO_2 emissions (Wang et al., 2019; Zheng et al., 2022). Wang et al. (2019) empirically estimated the impact of GVCs participation on per capita CO_2 emissions, using panel data of 62 countries from 1995 to 2011. They found an inverted-U relationship between GVCs and CO_2 and attributed it to the combined results of scale, technique spillover, composition, and competition effects. Moreover, Wang et al. (2019) studied the impact of GVCs position on CO_2 emissions in China and found that the relationship between participation degrees in GVCs and CO_2 emissions is an inversely U-shaped relation. Similarly, by using firm-level data in China, Zheng et al. (2022) found a non-linear relationship between GVCs participation and environmental pollution.

Regarding GVCs participation indices such as backward and forward participation, Qian et al. (2022) and Jithin & Sania (2023) had similar results. Specifically, by using national-level and industry-level data from 12 RCEP member countries, Qian et al. (2022) found that countries reduce their emissions through forward participation; however, an increase in GVCs backward participation would significantly increase their CO_2 emission. Meanwhile, Jithin & Sania (2023) investigated the impact of GVCs) participation on CO_2 emissions in 61 economies using OECD data from 2000 to 2018 and revealed that the direction of participation in GVCs matters, as forward participation has varying effects on CO_2 emissions, however, backward participation reduces CO2 emissions in both developing and developed economies.

As for using GVCs position index as an indicator of GVCs participation, Rai & Sen (2024) have presented an analysis of 62 developing and developed economies from 1995 to –2018. The results have shown that the overall position in GVCs positively affects CO_2 emissions for developing countries but a causal relationship does not exist for the developed countries. The developed countries attain a higher participation index but a lower position index. On the other hand, developing countries with fewer stringent environmental regulations may opt for an upstream position (more export-oriented) and by design specialize in more pollution-intensive industries.

In conclusion, the environmental impacts of GVCs depend on a country's position within the value chains, its level of participation, and its stage of economic development. This research found that: (1) previous studies have predominantly analyzed the relationship between participation in GVCs and carbon emissions using the GVCs participation index, which is composed of backward and forward linkages; meanwhile, the GVCs position index, considered more optimal, has received less attention; (2) while some studies have analyzed the impact of GVCs on carbon emissions globally, few have delved into specific regions. To the best of the authors' knowledge, the Asia-Pacific region has been largely overlooked in previous research; (3) due to data limitations, prior studies typically used data before 2018. Consequently, this research aims to make the following key contributions: (1) This research addresses whether a country's GVCs position, or its upstream movement, influences carbon emissions; (2) This research conducts an in-depth analysis of the impact of GVCs on carbon emissions in selected Asia-Pacific countries, where nations are both involved in GVCs and have substantial carbon emissions; (3) by employing the latest data from the OECD's TiVA 2023, this research covers the period from 1995 to 2020.

The following sections of the study are as follows: Section 2 presents the methods; Section 3 details the results; and Section 4 discusses the conclusions and implications.

2. Methods

2.1. Calculation of GVCs position index

This study employs the GVCs position index for measurement, which is considered superior to the commonly used GVCs participation index (Rai & Sen, 2024). The position index was proposed by Koopman et al. (2014) and is calculated as follows:

$$\boldsymbol{GVCs\ position} = \ln(1 + \boldsymbol{GVCs\ forward}) - \ln(1 + \boldsymbol{GVCs\ backward})$$

Specifically, GVCs backward and GVCs forward measure backward participation and forward participation in GVCs. Koopman et al., (2014) describe a country's gross exports as comprising two main categories: (1) final goods and (2) intermediate goods. The intermediate goods are further categorized into three groups: (a) those consumed directly in the importing country (FCIC); (b) those processed and then returned to the original exporting country (PEEC); and (c) those processed and sent to a third country (PETC). Each of these components, whether final or intermediate, includes both domestic value added (DVA) and foreign value added (FVA). The GVCs forward index measures the proportion of domestic value added in total foreign gross exports.

$$GVCs\ forward = \frac{DVA\ embodied\ in\ foreign\ export_{it}}{Gross\ export_{it}} = \frac{DVA_{PETC_{it}}}{Gross\ export_{it}}$$

The GVCs backward index measures the proportion of foreign value added in total gross exports.

$$GVCs\ backward = \frac{FVA_{it}}{Gross\ export_{it}} = \frac{FVA_{it}}{Gross\ export_{it}}$$
$$= \frac{FVA_{Final\ Goods_{it}} + FVA_{PCIC_{it}} FVA_{PEEC_{it}} + FVA_{PETC_{it}}}{Gross\ export_{it}}$$

The position index in GVCs reflects a country's overall position within the GVCs. A positive GVCs position value indicates that the country occupies an upstream position in the GVCs, contributing more value added to the exports of other countries. Conversely, a negative GVCs position value suggests that the country is in a downstream position, importing more value-added goods from abroad to support its own exports (Backer & Miroudot, 2013).

2.2. Model design and data

This study investigates the influence of GVCs position on carbon emissions in 22 selected Asia-Pacific countries from 1995 to 2020, using a newly adjusted model based on previous research. Based on previous studies (Abdouli & Hammami, 2020; Ali, 2021; Clancy et al., 2008; Grossman & Krueger, 1991; Rai & Sen, 2024), the authors propose a research model regarding the impact of GVCs position on carbon emissions as follows:

$$y_{it} = \beta_0 + \beta_1 * X_{it} + \beta_2 * Z_{it} + \epsilon_i + \tau_t + \varepsilon_{it} \qquad \text{(I)}$$

Where y_{it} represents the dependent variable, X_{it} are the main independent variables, Z_{it} are control variables, and τ_t and ϵ_i are fixed effects by year and country, respectively, while ε_{it} is the random error term.

Drawing from the research of (Rai & Sen, 2024), the authors select GVCs position as the main independent variable. Additionally, several control variables are included in the model to explain carbon emissions. Grossman & Krueger (1991), Apergis & Ozturk (2015) and Lau et al. (2019) assert that economic growth and carbon emissions have an inverse U-shaped relationship (the Environmental Kuznets Curve, EKC). Thus, our model is supplemented with GDP growth (gdpgr) and squared GDP growth (gdpgr2). Furthermore, Abdouli & Hammami (2020), Bah & Azam, (2017) argue that foreign direct investment positively impacts carbon emissions, while Clancy et al. (2008) and Madlener & Sunak (2011) emphasize the effect of urbanization on increasing CO_2 emissions. Consequently, the variables fdi and urban are incorporated to measure foreign direct investment and urbanization, respectively. Additionally, research by Ali (2021) and Zuhal & Göcen (2024) suggests that renewable energy consumption will reduce carbon emissions. Therefore, the authors include the variable rc to represent renewable energy consumption. Based on model (I), the authors propose the following research model:

$$CO2\_PC_{it} = \beta_0 + \beta_1 * GVC_{POS_{it}} + \beta_2 * gdpgr_{it} + \beta_3 * gdppc2_{it} + \beta_4 * fdi_{it} + \beta_5 * urban_{it} + \beta_6 * rc_{it} + \epsilon_i + \tau_t + \varepsilon_{it} \qquad \text{(II)}$$

Where CO2_PC, GVC_POS, gdpgr, gdpgr2, fdi, urban, rc represent per capita CO_2 emissions, position in GVCs, GDP growth, squared GDP growth, foreign direct investment, urbanization, and renewable energy consumption, respectively.

We expect $\beta_1 > 0$ as advancing upstream in global value chains requires countries to generate greater value-added, which may necessitate higher energy consumption and increased production in carbon-intensive industries. Based on the EKC hypothesis, we expect $\beta_2 > 0$ and $\beta_3 < 0$. This expectation arises because, in the early stages of development, countries prioritize economic issues and growth while neglecting environmental impacts. However, the ecological sensitivity of a society increases as development progresses (Ahmed & Wang, 2019). In other words, with higher growth, society becomes more concerned with environmental quality, and the positive effects of economic growth will be diffused, thereby leading to a reduction in carbon emissions. We also anticipate $\beta_4; \beta_5 > 0$ since foreign direct investment can provide opportunities to import polluting technologies or act as a driver to promote carbon-intensive production. Higher urbanization implies greater demand for resource and energy use, resulting in increased carbon emissions. We expect $\beta_6 < 0$ because renewable energy is both cost-effective and environmentally friendly, leading to reduced CO_2 emissions (Gielen et al., 2019).

The countries were chosen from the UNESCAP list due to the lack of a unified definition of the Asia-Pacific region and limitations in available databases. The data used to calculate the GVCs position in this study comes from the 2023 edition of the Trade in Value Added (TiVA) database. The authors utilize data from this edition because it is the most recent TiVA publication from the OECD and provides the latest updated data to address the limitations of data from other databases, which are only updated until 2018. The data for the dependent variable (CO2_PC) is sourced from the OECD database, while the control variables are drawn from the World Development Indicators database of the World Bank, aiming to create a balanced dataset and avoid missing data.

The variables utilized in the research model, data sources, and the expected signs of these variables are presented in the following table.

Table 1: The list of variables used in the research model

Variables	Variable description and measurement	Data sources	Expected signs	Previous studies
CO2_PC	Carbon emissions (metric tonnes per capita)	OECD		
GVC_POS	GVCs position	TiVA OECD	+	Rai & Sen (2024)
gdpgr	Gross domestic product growth (annual %)	WDI	+	Apergis & Ozturk (2015); Grossman & Krueger (1991) and Lau et al. (2019)
gdpgr2	Square of gross domestic product growth (%)	WDI	-	
fdi	Foreign direct investment net inflow (% of GDP)	WDI	+	Abdouli & Hammami (2020); Bah & Azam, (2017)
urban	Urban population (% of total population)	WDI	+	Clancy et al. (2008) Madlener & Sunak (2011)
rc	Renewable energy consumption (% of total final energy consumption)	WDI	-	Ali (2021); Zuhal & Göcen (2024)

Source: Compiled by the authors

2.3. Choice of estimation strategy for panel data

The authors estimate the research model using panel data analysis methods, including Pooled OLS (POLS), Fixed Effects Model (FEM), and Random Effects Model (REM). Following the procedure outlined by Park (2011), they determine the most suitable model through three steps: first, by running regressions for both POLS and REM models; second, conducting the Breusch-Pagan Lagrange Multiplier (LM) test to choose between POLS and REM, with REM preferred if the null hypothesis is not rejected; and third, by performing regressions for REM and FEM, followed by the Hausman test to select between REM and FEM. If the null hypothesis is rejected, FEM is chosen; otherwise, REM is selected. Once the optimal model is identified, the authors check for potential errors and apply the Feasible Generalized Least Squares (FGLS) method if necessary, ensuring model reliability for subsequent analysis.

3. Results

The author will proceed to select the most suitable model for the research data sample using three estimation models: POLS, FEM, REM as proposed by Park (2011).

For the dataset comprising 22 Asia-Pacific countries during the period 1995 – 2020, when choosing between the POLS and REM models using the Breusch-Pagan LM test, the author obtained a P-value of 0.000, indicating that the REM model is more appropriate than POLS. Subsequently, conducting the Hausman test yielded a P-value of 0.2437, which is greater than 0.05, indicating that the REM model is more suitable than FEM. Therefore, among the three methods POLS, REM, FEM, REM is the most appropriate for the research sample.

In the random effects model, there exist errors with changing variance and serial correlation. With a research sample consisting of panel data (N = 22 countries, T = 26 years), the author employed the Feasible Generalized Least Squares (FGLS) model estimation to address these issues of serial correlation and changing error variance based on the study by (Ha et al., 2021). The FGLS model is the author's final choice.

The estimation results of POLS, FEM, REM, and FGLS for the model with the main independent variable being the GVCs position (GVC_POS) are presented in the table.

Table 2: Regression models

Model	**(1)**	**(2)**	**(3)**	**(4)**
Explained: CO2_PC	**OLS**	**FE**	**RE**	**FGLS**
GVC_POS	2.412*** [15.04]	0.456*** [2.70]	0.373** [2.18]	0.764*** [9.77]
gdpgr	0.0518 [1.14]	0.0336** [2.23]	0.0337** [2.25]	0.0142*** [3.78]
$gdpgr^2$	-0.0111** [-2.33]	-0.00563*** [-3.29]	-0.00570*** [-3.34]	-0.000812* [-1.76]
lnfdi	0.415*** [4.45]	-0.0881* [-1.74]	-0.0894 [-1.76]	0.019 [1.20]
urban	0.0626*** [7.78]	0.108*** [9.74]	0.107*** [9.17]	0.0851*** [22.52]
rc	-0.0817*** [-10.28]	-0.0124* [-1.67]	-0.0103 [-1.37]	-0.0449*** [-12.26]
_cons	3.993*** [5.96]	-0.28 [-0.28]	-0.242 [-0.30]	1.280** [4.83]
N	556	556	556	556
R-sq	0.729		0.28	
Breusch and Pagan Lagrangian test	chibar2(01) = 4612.87 Prob > chibar2 = 0.0000			
Hausman test	chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 12.39 Prob>chi2 = 0.0537			
Wooldrige test	F(1, 22) = 8.646 Prob > F = 0.0076			

****, **, * represent significant levels at 1%, 5%, and 10%, respectively.*
Standard deviation is shown in parentheses (), and the p-value of the test is shown in brackets [].

Source: Data processing result in Stata by authors

Model correction and discussion of results

The model is the FGLS model, the author's final choice for analyzing the influence of GVCs position on CO_2 emissions. The equation estimating the impact of Global Value Chains position on CO_2 emissions based on the FGLS model is as follows:

$$\widehat{CO2\_PC} = 1.280 + 0.764 * GVC\_POS + 0.0142 * gdpgr - 0.000812 * gdpgr^2 + 0.0190 * lnfdi + 0.0851 * urban - 0.0449 * rc$$

From the FGLS model, it can be observed that the GVCs position (GVC_POS) exhibits a positive relationship with CO_2 emissions, suggesting that GVCs participation contributes to CO_2 emissions in the selected 22 economies. An increase of one unit in GVCs position results in an average per capita CO_2 emissions increase of 0.764 metrics tons per capita, with statistical significance at the 1% level. From the FGLS model, it can be observed that the GVCs position (GVC_POS) shows a positive relationship with CO_2 emissions, suggesting that a country moving upstream in the GVCs leads to an increase in carbon emissions. This result is consistent with the study by Rai & Sen (2024). It implies that as a country becomes more integrated into global value chains, contributing more value-added and taking on production stages, its participation in upstream production processes related to international trade may contribute to higher CO_2 emissions. The positive correlation may be driven by the increased scale of production, energy consumption, and transportation associated with cross-border trade. Furthermore, countries deeply embedded in GVCs may engage in more carbon-intensive production activities, thereby increasing their environmental footprint. This finding underscores the potential environmental trade-offs associated with deeper integration into global trade networks, where the economic benefits of GVCs participation may come with higher environmental costs.

In addition to the effects of the core variable, the influence of control variables on CO_2 emissions is also notable. The positive coefficients of GDP growth rate (gdpgr) and the negative coefficients of GDP growth rate squared (gdpgr2), both significant at the 10% level, support the Environmental Kuznets Curve (EKC) hypothesis within our dataset. These findings align with previous research by (Grossman & Krueger, 1991; Apergis & Ozturk, 2015; Lau et al., 2019). This indicates that as income levels increase, environmental concerns may initially be deprioritized, but beyond a certain income threshold, there is a shift towards a greater focus on environmental sustainability.

The analysis shows that Foreign Direct Investment (FDI) significantly increases CO_2 emissions, supporting the Pollution Haven Hypothesis (PHH) by (Copeland & Taylor, 1994). This effect is confirmed by Bah & Azam (2017) and Abdouli & Hammami (2020), indicating that FDI adversely impacts environmental quality, especially in developing countries.

Urbanization is also positively correlated with CO_2 emissions, with significant coefficients at the 1% level. Studies by Clancy et al. (2008) and Madlener & Sunak (2011) confirm that urban expansion leads to higher industrial activity and energy consumption, thereby increasing emissions.

In contrast, renewable energy consumption is associated with reduced CO_2 emissions. A one-unit increase in renewable energy leads to a 0.0449 unit decrease in per capita CO2 emissions, as supported by Ali (2021) and Zuhal & Göcen (2024). This highlights the benefits of renewable energy in improving environmental quality.

4. Conclusion and Implications

4.1. Conclusion

This study aimed to explore the relationship between a country’s position in global value chains (GVCs) and carbon emissions, focusing on 22 selected Asia-Pacific countries from 1995 to 2020. The findings reveal a significant positive relationship between GVCs position and per capita CO_2 emissions. Specifically, as countries move upstream in GVCs, becoming more involved in the production of intermediate goods and adding more value to exports, their carbon emissions tend to increase. This aligns with the hypothesis that deeper integration into GVCs, particularly in upstream positions, results in greater energy consumption and carbon-intensive activities. Additionally, the control variables, including GDP growth, FDI, urbanization, and renewable energy consumption, also provide valuable insights. The results suggest that while economic growth initially increases emissions, it may eventually contribute to environmental improvements beyond a certain threshold, consistent with the Environmental Kuznets Curve (EKC). Furthermore, foreign direct investment and urbanization are associated with higher emissions, whereas renewable energy consumption plays a crucial role in reducing CO_2 emissions.

4.2. Implications

According to the quantitative results above, the authors may propose some policy implications related to GVC to improve environmental quality. Generally, each government should improve the GVCs position and move up to forward production segments. Achieving this involves multiple stakeholders, including the government, private sector, and civil society.

First, countries must enhance energy efficiency in their upstream production activities and transform their industries by optimizing energy structure and improving energy efficiency. More policy supports are needed to incite green energy technology breakthroughs and widen the use of clean energy consumption, such as replacing fossil energy consumption with renewable energy like solar energy, hydro energy, wind power, and so on.

Second, these countries should increase human capital investment and develop knowledge-intensive service personnel to improve the quality and productivity of factors and enhance the country’s competitiveness. This can be achieved through investments in education, training, and vocational programs.

Next, nations should diversify and upgrade industries by encouraging diversification into higher-value industries, such as manufacturing, services, or technology, and upgrade existing industries to increase their competitiveness.

Last but not least, promoting innovation and research and development (R&D) is crucial. This can be achieved by encouraging innovation and R&D through investments in science and technology and providing incentives for companies to invest in R&D.

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Factors Influencing the Achievement of Net Zero Targets by Businesses in Dong Nai

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Abstract

The study focuses on identifying and analyzing factors affecting the ability of businesses in Dong Nai province to achieve the Net Zero goal. The study conducted a survey of businesses in Dong Nai in 2024 shows that there are 07 main factors affecting the achievement of this goal, including: Policies and regulations; Investment and finance; Technology and innovation; Awareness and training; Cooperation and networking; Economic and social challenges; Management and leadership. The study not only provides an overview of the impact factors but also proposes solutions to improve the ability of businesses to achieve Net Zero goals, contributing to the sustainable development of the region. From there, the author offers solutions and recommendations to help businesses have the ability to manage waste and emissions, contributing to sustainable development and environmental protection.

Keywords: *Enterprise, Dong Nai, Netzero*

1. Introduction

Net Zero is an international objective adopted by numerous nations and organizations to guarantee a sustainable and safe future for the planet. While achieving Net Zero presents challenges, it also offers significant opportunities for the global economy. Its implementation has the potential to drive positive changes across various sectors, including energy, technology, and investment, and foster long-term sustainable development.

Net Zero refers to achieving a balance between the greenhouse gases released into the atmosphere and those removed from it. The aim is to reach net zero emissions within a set timeframe, typically by the mid-21st century, to prevent global temperature increases and mitigate the harmful impacts of climate change (Bolton, 2021).

Net Zero plays a crucial role in the sustainable development of businesses by promoting reduced carbon emissions and fostering long-term environmental responsibility. By committing to Net Zero, businesses can minimize their ecological footprint, enhance resource efficiency, and contribute to climate change mitigation (Gulen et al., 2024). This not only helps protect the environment but also boosts a company's reputation, resilience, and competitiveness in a market increasingly driven by sustainability-conscious consumers and investors. Achieving Net Zero can also lead to cost savings through energy efficiency and innovation in clean technologies, supporting overall sustainable growth.

The Net Zero objective is more than just an environmental obligation; it is also a strategic business approach. By pursuing Net Zero, companies not only support sustainable development but also enhance operational efficiency, boost brand reputation, and generate lasting value for both their business and the wider community (Gomes et al., 2024).

2. Theoretical framework and Literature review

2.1. Theoretical framework

Environmental Management Theory (1970): This theory emphasizes the importance of environmental management in business activities. It believes that businesses need to integrate environmental factors into their strategies and operational processes. The study can look at how legal regulations and environmental policies affect a company's decision to take measures to reduce emissions.

Innovation Theory (1990): This theory holds that innovation is a key factor to help businesses develop and compete. The application of new technology not only improves performance, but also helps to minimize the negative impact on the environment. The study can analyze how green technology and innovative solutions support businesses in achieving Net Zero goals.

Organizational Behavior Theory (1980): This theory focuses on how organizational culture, leadership, and employee perceptions affect the performance of a business. "The study can investigate the level of awareness of the importance of Net Zero among leaders and employees, thereby examining its impact on actions and decisions in the business.

Quality Management Theory (1980): This theory emphasizes the importance of quality management in all business processes. It involves continuous improvement and process optimization. The study could look at a business's ability to manage waste and emissions, and how this affects its ability to achieve sustainability goals.

Network Theory (1990): This theory holds that cooperation between parties in a network can create added value and synergy. The study can analyze the role of collaboration between businesses and other stakeholders in sharing experiences and resources to achieve the Net Zero goal.

The above theories provide a solid theoretical basis for studying the factors affecting the ability of enterprises in Dong Nai province to achieve the Net Zero goal. The application of these theories will help to better understand the internal and external factors affecting the sustainable transformation of the business, thereby providing appropriate and effective solutions.

2.2. Literature review

Research by Aguilera, R. V., Aragón-Correa, J. A., Marano, V., & Tashman, P. A. (2021): “As corporations face growing scrutiny over their environmental impact, scholars are increasingly focusing on corporate governance's role in driving sustainability efforts. However, a comprehensive understanding and research agenda remain lacking. Our framework connects governance actors to sustainability outcomes, identifies knowledge gaps, and proposes novel approaches for future research”.

Research by Hakovirta et al. (2023) Addressing climate change now tops global corporate agendas, requiring innovation in technology, policy, and finance. This article explores how start-ups play a crucial role in accelerating climate innovation and supporting corporate sustainability strategies.

Research by Erb et al. (2022): “Business leadership is essential for transitioning to a zero-carbon global economy. Companies are under increasing pressure from investors, customers, and employees to set climate targets with actionable plans. Many large firms are now committing to long-term GHG reduction goals, including net-zero by 2050, using strategies like renewable energy adoption and carbon removal investments”.

Research by Chan, Cheung, & Shen (2024): “The G20 emphasized the urgency of financing the net-zero transition, but investors lack a framework to assess the credibility of corporate transition claims. Negative screening based on GHG emissions remains common. This paper uses economic modeling and interviews to suggest that a firm’s transition capacity, urgency, and pathway concavity are key factors in assessing its net-zero potential. It also explores how the TCFD framework can aid in evaluating corporate transition credibility”.

Research by Mazhar et al. (2024): “Small and medium-sized enterprises (SMEs) are vital to the UK and EU economies, making up most businesses and employing many people. Despite their positive impact, SMEs contribute 43–53% of greenhouse gas emissions and face challenges in carbon management due to limited support. This research investigates the effect of a university-led programme on helping SMEs develop carbon management strategies, revealing that universities play a key role in assisting SMEs with transitioning to net zero through resource monitoring, policy development, and target setting”.

Research by Xu & Adams (2024): “Amid the climate crisis, countries like the US, UK, and France are working toward net-zero emissions targets, with the UK aiming for 2050. SMEs, responsible for nearly half of the UK's business emissions, are crucial to this effort. However, action among SMEs remains limited. This research examines factors driving pro-NetZero actions among UK SMEs using a mixed-method approa{Xu, 2024 #381}ch, revealing that owner-managers' attitudes and perceived behavioral control directly influence their intentions, while societal and stakeholder pressures have an indirect effect”.

Research by Sharma et al. (2024): “This research examines how various resources, such as tangible assets, human expertise, and intangible assets, influence the development and implementation of net-zero practices and impact SMEs' environmental performance. It also assesses the moderating role of digitalization in this process. Analyzing data from 291 SMEs using structural equation modeling, the study emphasizes the importance of managing resources and capabilities, especially intangible assets like organizational culture and learning, for achieving net-zero goals. Additionally, leveraging Industry 4.0 technologies is highlighted as crucial for SMEs in advancing towards a sustainable net-zero economy”.

Based on these theories, the author conducted a survey of enterprises in Dong Nai and analyzed elements influencing the achievement of Net Zero targets by businesses through the following research model.

3. Methods

The author surveyed 240 businesses in Dong Nai. After that, 226 votes were obtained to complete and pass the requirements. After that, the author cleans the data and puts it into analysis through SPSS software. The time is from June, 2024 to September, 2024.

3.1. Research model

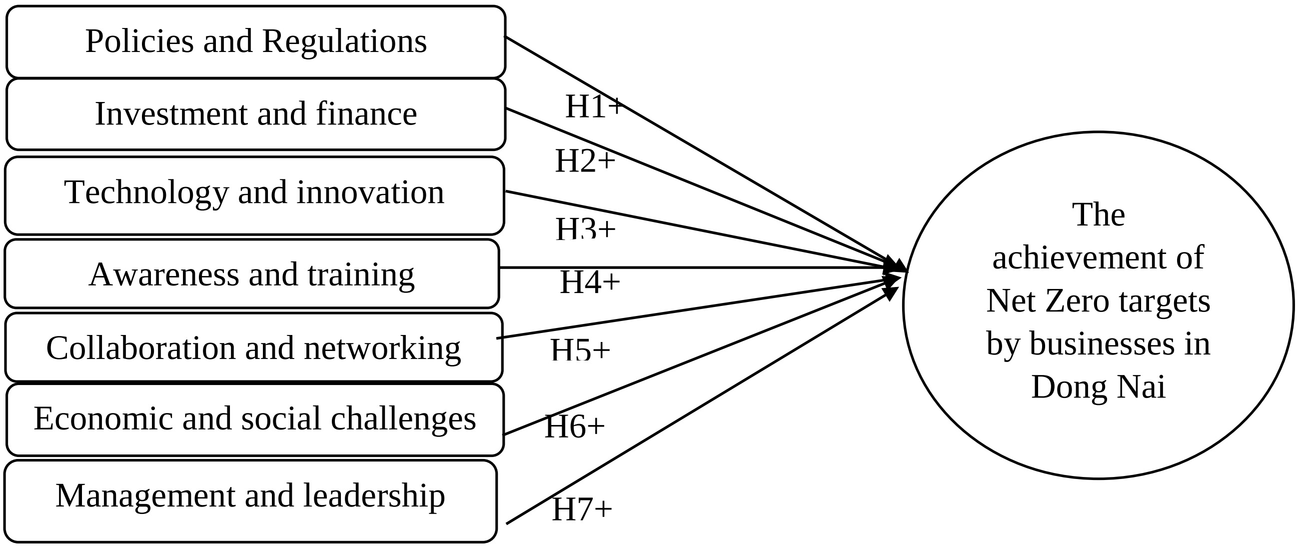

Figure 1: Research model

Source: Compiled by the author

3.2. Research hypotheses

H1: "Policies and regulations positively influence on the achievement of Net Zero targets by businesses in Dong Nai ".

H2: "Investment and finance positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

H3: "Technology and innovation positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

H4: "Awareness and training positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

H5: "Cooperation and networking positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

H6: "Economic and social challenges positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

H7: "Management and leadership positively influence on the achievement of Net Zero targets by businesses in Dong Nai".

F: " The achievement of Net Zero targets by businesses in Dong Nai".

The scale of the observed variable, shown in detail in Table 1.

Table 1: Scale table of observed variables

STT	Ampersand	Observation variables
1	***Policy and Regulatory Scale (PR)***	
1.1	PR1	The region offers detailed instructions for enforcing rules on emission control, waste management, and the growth of renewable energy.
1.2	PR2	Local agencies have supportive policies to encourage businesses to invest in green technology and reduce emissions.
1.3	PR3	There are specific programs implemented locally to raise awareness and support businesses in implementing environmental regulations.
1.4	PR4	Businesses understand the legal framework related to local and national regulations on emissions and environmental protection.
1.5	PR5	The company has established long-term strategies to support sustainability, with clear targets for cutting emissions and safeguarding the environment.
1.6	PR6	Local authorities coordinate to supervise and inspect the implementation of environmental regulations.
2	***Investment and Finance Scale (IF)***	
2.1	IF1	Businesses often have difficulty accessing capital for sustainable projects.
2.2	IF2	The loan procedure is usually lengthy and complex, hindering businesses from quickly funding sustainable projects.
2.3	IF3	Businesses lack sufficient understanding of financial products and how to secure funding, particularly for environmental projects.
2.4	IF4	Businesses may not have enough information to assess the risks and benefits of investing in sustainable technology, leading to hesitancy in borrowing.
3	***Technology and Innovation Scale (TI)***	
3.1	TI1	The ability to apply new technologies in energy production and management to reduce emissions.
3.2	TI2	Employing eco-friendly technologies, like solar, wind, and heat recovery systems, reduces emissions in production processes.
3.3	TI3	Applying smart energy management technology helps businesses optimize energy use, thereby reducing greenhouse gas emissions.
3.4	TI4	Improve production processes and use environmentally friendly raw materials.
4	***Awareness and Training Scale (AT)***	
4.1	AT1	Management's awareness of climate change and the Net Zero goal's significance crucially shapes the business's strategy and commitment.
4.2	AT2	Employee understanding of Net Zero goals fosters a sustainable company culture, motivating involvement in environmental protection efforts.
4.3	AT3	The company regularly organizes employee training sessions on sustainable development and environmental management.
4.4	AT4	Encourage the sharing of experiences and good practices from other businesses that have been successful in implementing the Net Zero goal.
5	***Collaboration and Networking Scale (CN)***	
5.1	CN1	Cooperation between businesses helps to combine resources, knowledge and experience, creating synergies to deal with common challenges.

STT	Ampersand	Observation variables
5.2	CN2	Sharing processes and good practices helps businesses optimize operations, save costs, and enhance production efficiency.
5.3	CN3	Collaborate with NGOs and international networks to receive support and knowledge.
6	***Economic and Social Challenges Scale (ES)***	
6.1	ES1	Competition in the industry can hinder investment in sustainable projects.
6.2	ES2	Businesses competing on price face higher costs with sustainable technology investments.
6.3	ES3	Eco-friendly projects take longer to become profitable, causing businesses to hesitate in investing.
7	***Management and Leadership Scale (ML)***	
7.1	ML1	Effective waste and emission management helps businesses minimize resource waste, improve production efficiency, and save costs.
7.2	ML2	Businesses need to comply with regulations on emissions and waste management, thereby avoiding legal risks and fines.
7.3	ML3	The determination of the management in implementing the Net Zero goal.

Source: Compiled by the author

4. Results

4.1. Reliability testing of scales

Table 2 indicates that the Cronbach's Alpha coefficients range from 0.787 to 0.913, exceeding 0.5, confirming the scales' reliability. The total variable correlation coefficients range from 0.394 to 0.840, above 0.3, showing a correlation between variables. Therefore, the variables are suitable for exploratory factor analysis (EFA).

Table 2: Testing the reliability of independent variables

Scale	Coefficient Cronbach's Alpha	Correlation coefficient Sum variables
1. PR	.913	.477
2. IF	.858	.498
3. TI	.852	.633
4. AT	.787	.394
5. CN	.893	.464
6. ES	.878	.554
7. ML	.796	.840
8. F	.807	

Source: Extracted from SPSS

4.2. EFA analysis with independent variables

Table 3 shows: "KMO coefficient = 0.824 > 0.5 of independent variables, so this EFA analysis is appropriate. And testing Barlett with Sig. = 0.000 significance; In terms of linear correlation, the observed variables from PR1 to ML3 have a high correlation with independent factors. From the results of the matrix analysis, the observed variables have a load coefficient of > 0.5 and are arranged in order, so the model will not have any kind of bad variables".

Table 3: Rotation matrix of independent factors

Numerical order	Variables	Factor Load Factor						
		1	2	3	4	5	6	7
1	PR1	.867						
	PR2	.844						
	PR3	.829						
	PR4	.804						
	PR5	.789						
	PR6	.736						
2	IF1		.863					
	IF2		.835					
	IF3		.774					
	IF4		.725					
3	TI1			.823				
	TI2			.741				
	TI3			.729				
	TI4			.721				
4	AT1				.855			
	AT2				.816			
	AT3				.700			
	AT4				.648			
5	CN1					.915		
	CN2					.841		
	CN3					.833		
6	ES1						.848	
	ES2						.848	
	ES3						.799	
7	ML1							.842
	ML2							.821
	ML3							.784

Source: Extracted from SPSS

4.3. EFA analysis with dependent variables

Table 4 shows a KMO coefficient of 0.809, which exceeds 0.5, and Bartlett's test has a significance value of 0.000. The factor loadings are all greater than 0.5, indicating good convergence and reliability of the variables.

Table 4: EFA results with dependent variables

Observation variables	Factor Load Factor
	1
F1	.625
F2	.642
F3	.770
F4	.539
F5	.607
F6	.691
F7	.913

Source: Extracted from SPSS

4.4. Correlation analysis

Table 5 shows that the correlation coefficient between independent and dependent variables ranges from 0.123 to 0.714, indicating a strong relationship. All independent variables have Sig. values > 0.05, supporting the hypothesis. The overall correlation coefficient is 0, indicating no variation in the model. Additionally, the VIF coefficients for independent variables are all < 2, signifying no multicollinearity issues (Table 6).

Table 5: Correlation matrix between independent and dependent variables

		Correlations							
		PR	**IF**	**TI**	**AT**	**CN**	**ES**	**ML**	**F**
PR	Pearson Correlation	1	.314**	.290**	.290**	.291**	.317**	.230**	.550**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
	N	226	226	226	226	226	226	226	226
IF	Pearson Correlation	.314**	1	.396**	.177**	.322**	.362**	.312**	.523**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000
	N	226	226	226	226	226	226	226	226
TI	Pearson Correlation	.290**	.396**	1	.362**	.354**	.470**	.386**	.714**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000
	N	226	226	226	226	226	226	226	226
AT	Pearson Correlation	.290**	.177**	.362**	1	.155**	.257**	.187**	.471**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000
	N	226	226	226	226	226	226	226	226
CN	Pearson Correlation	.291**	.322**	.354**	.155**	1	.344**	.183**	.499**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000
	N	226	226	226	226	226	226	226	226
ES	Pearson Correlation	.317**	.362**	.470**	.257**	.344**	1	.166**	.542**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	
	N	226	226	226	226	226	226	226	226
ML	Pearson Correlation	.230**	.312**	.386**	.187**	.183**	.166**	1	.352**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000
	N	226	226	226	226	226	226	226	226
F	Pearson Correlation	.550**	.523**	.714**	.471**	.499**	.542**	.352**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
	N	226	226	226	226	226	226	226	226

*Note: Symbol **: Indicates that this pair of variables has a linear correlation with a confidence level of 99% (corresponding to a significance level of 1% = 0.01).*

Source: Extracted from SPSS

4.5. Multiples regression analysis

Table 6 indicates that the adjusted R^2 value of 0.862, or 86.2%, reflects the direct impact of factors such as policies and regulations, investment and finance, technology and innovation, awareness and training, cooperation and networking, economic and social challenges, and management and leadership on achieving Net Zero targets by businesses in Dong Nai. The F test shows a very low significance value (Sig. = 0.000), suggesting the research model fits the survey sample well. All independent variables (PR, IF, TI, AT, CN, ES, ML) are statistically significant with Sig. < 0.05. The variance inflation factor (VIF) ranges from 1.217 to 1.716, indicating no multicollinearity issues among the independent variables.

$$Y = -0.558 + 0.365*CD + 0.261*CQ + 0.162*DT + 0.160*ND + 0.157*HM + 0.116*KX + 0.107*QL$$

Table 6: Results of regression analysis

Model		Unstandardized regression coefficients		Normalized regression coefficients	t	Sig. Acceptance	Multiline Statistics	
		B	Standard Error	Beta			Variance magnification factor	VIF
1	Constant	-.588	.204		-2.881	.004		
	PR	.288	.043	.261	6.739	.000	.783	1.277
	IF	.123	.030	.162	4.103	.000	.758	1.320
	TI	.277	.034	.365	8.109	.000	.583	1.716
	AT	.164	.039	.160	4.214	.000	.822	1.217
	CN	.172	.042	.157	4.059	.000	.787	1.271
	ES	.093	.033	.116	2.829	.000	.700	1.429
	ML	.119	.042	.107	2.842	.000	.831	1.203
R2 calibration: 0.862 Durbin-Watson Statistics: 1,882 Statistics F(ANOVA): 90,003 Significance Level (Sig. of ANOVA): 0.000								

Source: Extracted from SPSS

5. Conclusion and Recommendations

The inspection results indicate that the research model is suitable, identifying seven key factors influencing Net Zero target achievement by businesses in Dong Nai: (1) Investment and finance; (2) Policies and regulations; (3) Technology and innovation; (4) Awareness and training; (5) Cooperation and networking; (6) Economic and social challenges; (7) Management and leadership. Based on this, the author suggests the following recommendations:

Firstly, to achieve the Net Zero targets, Dong Nai businesses must use suitable investment and financial strategies. Support from government, financial institutions, and the community is crucial for overcoming challenges and reaching sustainability goals through these measures: establishing dedicated investment funds for sustainable and green projects; promoting government support with concessional loans or subsidies for clean technology and renewable energy; fostering public-private partnerships for sustainable initiatives; investing in R&D; creating a sustainable financial network; enhancing training and awareness; and developing green financial products.

Secondly, to help Dong Nai businesses reach Net Zero, effective policies and regulations are essential. Solutions include: creating a clear legal framework; promoting business participation in sustainability programs; offering technical support; enforcing environmental reporting regulations; providing tax incentives and financial aid for clean technology; organizing environmental management and sustainability training; and fostering collaboration among governments, businesses, NGOs, and communities.

Thirdly, the adoption of technology and innovation is crucial for Dong Nai businesses to achieve Net Zero. Solutions include: investing in renewable energy sources like solar, wind, and biomass; using energy-efficient equipment; investing in carbon capture and storage technologies; implementing smart technology such as IoT for monitoring energy and emissions; partnering with research and educational institutions for new sustainable technologies; and hosting startup competitions and innovation events to foster new sustainability ideas.

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The Impact of Climate Risk on the Lending Behavior of Banks in Vietnam and the Mediating Role of Bank Liquidity Risk

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Abstract

This study aims to investigate the relationship between climate risk and commercial banks' lending behavior in Vietnam, as well as the mediating role of bank liquidity risk. The study is conducted using data from 23 listed commercial banks in Vietnam and the Climate Risk Index (CRI) obtained from Germanwatch for the period 2010-2019. We employed descriptive statistics, two-stage least squares (2SLS), and Generalized Method of Moments (GMM) for the analysis. The results indicate that climate risk has a significant impact on bank lending behavior, meaning that commercial banks reduce lending when extreme weather events occur. Additionally, liquidity risk acts as a mediator in the relationship between climate risk and commercial banks' lending behavior.

Keywords: *Bank lending behavior, bank liquidity risk, climate risk, commercial bank, Vietnam*

1. Introduction

In today's context of industrialization and modernization, human production activities, primarily carbon dioxide (CO_2) and greenhouse gas (GHG) emissions into the atmosphere, have caused global warming, leading to climate change and affecting a country's economy. According to the ECB (2020), climate risk is the level of exposure and hazard that not only affects people's quality of life but also has consequences for a country's financial system (Cardona et al., 2012, Oppenheimer et al., 2015). This has contributed to influencing the perception of climate risk among commercial banks through lending behavior. Empirical evidence, as shown in Brei et al. (2019), suggests that after a hurricane hit the Caribbean, commercial banks had to face liquidity risk due to individuals withdrawing deposits en masse to meet essential needs during the disaster. Cortés and Strahan's research (2017) indicates that after natural disasters, credit in markets is affected and decreases by 50 cents for every dollar of loans in affected areas. Meanwhile, Vietnam is considered one of the five countries most affected by climate change globally and ranked 13th worldwide in 2022 (COP27). This contributes to influencing the perception and governance style of commercial banks in Vietnam. However, there is currently very little research on the impact of climate risk on bank lending behavior in Vietnam. Therefore, the purpose of this study is to examine the relationship between climate risk and bank lending behavior through the mediating role of liquidity risk.

2. Literature review

2.1. The direct effect of climate risk on bank lending behavior

Climate risk can have direct impacts on banks' decisions to reduce credit supply. Firstly, the decline in collateral value due to extreme weather events increases the credit risk factor, forcing banks to adjust their risk pricing models and adopt stricter risk management measures. According to (Li & Wu, 2023), flooded houses, landslides, damaged factories, and submerged production equipment caused by extreme weather events like storms and flash floods reduce the repayment capacity of borrowers, increasing their credit risk. As a result, to avoid loan losses due to rising credit risk, banks tend to reduce their loan supply. Secondly, banks may be reluctant to provide loans to businesses with high credit risk caused by climate risks. A previous study showed that some businesses affected by climate risks proactively adjust their capital structure by reducing leverage through lower debt financing, which leads to a reduced demand for credit (Ginglinger & Moreau, 2023). Thirdly, due to various net-zero emission policies and sustainable financial regulations from governments worldwide, banks have become increasingly aware of and responsible for environmental protection. As a result, banks are reducing the supply of capital to businesses that violate environmental protection policies or have high carbon emissions. Following the Paris Agreement, high-emission businesses now face greater difficulties in accessing capital, despite the trend of declining loan interest rates (Bruno & Lombini, 2023).

Based on previous studies on the impact of climate risk on bank lending behavior, we propose the following hypothesis:

H1: Climate risk has a direct negative impact on bank lending behavior

2.2. The mediating role of bank liquidity risk to the relationship between climate risk and bank lending behavior

Climate change is not only an environmental challenge but also a serious financial risk, particularly for the banking sector. Climate risk, by increasing liquidity risk, can reduce bank lending activities. These risks affect the psychology of institutions and individuals, increasing the likelihood of mass withdrawals from banks. Meanwhile, bank lending mechanisms involve repayment upon maturity. As a result, banks may face liquidity risks if they do not have enough cash reserves to meet customer demands. For example, extreme natural disasters have negatively impacted the financial behavior of individuals and businesses, leading to increased cash reserves and reduced bank deposits to ensure essential needs (Batten et al., 2016). This affects the liquidity of the system, creating new challenges for lending activities. Additionally, investors and depositors may withdraw their money from banks due to a loss of trust if banks continue to lend to businesses that violate emission regulations and cause severe environmental pollution. The reason for this action by banks is that they believe traditional businesses with heavy production models, often associated with high carbon emissions, tend to own more tangible assets. This makes it easier for them to access loans since they have more collateral to offer (Iovino et al., 2021). Therefore, the liquidity of banks will decrease significantly, and the structure of loan allocation and supply will also decline.

Based on previous studies on the mediating role of bank liquidity risk, we propose the following hypothesis:

H2: The mediating variable of liquidity risk transmits the negative effects of climate risk to bank lending behavior

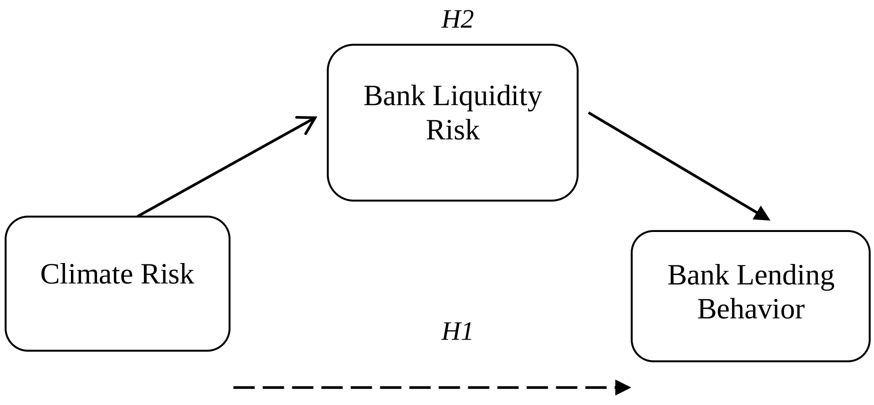

Figure 1: Conceptual Model of the research

Source: Authors' development from literature review

3. Methods

To analyze the impact of climate risks on the lending behavior of commercial banks in Vietnam, this study utilized secondary data from 23 commercial banks over a 10-year period from 2010 to 2019, along with several indicators from other reliable sources such as the Climate Risk Index (CRI) from Germanwatch, inflation rates, and GDP growth from the World Bank from 2010 to 2019.

Firstly, the study used descriptive statistics and correlation coefficient matrix to provide an overview of bank lending behavior during the aforementioned period. Then, the study employed the two-stage least squares (2SLS) method to estimate the structural parameters of the equation and to detect endogeneity in the model. To address this limitation, the study used the Generalized Method of Moments (GMM). GMM is a flexible estimation method that allows the use of multiple instrumental variables to resolve endogeneity and heteroskedasticity. By transforming first differences and creating a matrix of instrumental variables, GMM controls for unobserved factors and prevents endogeneity.

The two key tests in the GMM estimation method that we performed are the Overidentifying Restrictions test, also known as the Hansen J-Test, and the AR2 test (Arellano & Bond, 1991). The Hansen test is a necessary check in cases where there are more instrumental variables than the number of variables in the model, to determine whether the instrumental variables are correlated with the model's residuals. Meanwhile, the Second Order Autocorrelation test (AR2) checks for the absence of second-order serial correlation in the first-differenced residuals. Furthermore, Structural Equation Modeling (SEM) was employed to simplify the testing of the mediation hypothesis.

4. Results

4.1. Descriptive statistics

The results from descriptive statistics show that during the period from 2010 to 2019, the growth in lending behavior of Vietnamese commercial banks was relatively large, with an average annual value of 36.96%. At the same time, the volatility of bank liquidity risk and climate risk were at similar levels (approximately 15%), indicating that the banks' liquidity risk management in response to the impacts of weather and climate changes was relatively stable.

Table 1: Descriptive statistics of variables

Variable	Obs	Mean	Std. dev.	Min	Max
Bank Lending Behavior	230	36.96	56.74	-22.09	273.71
Bank Liquidity Risk	230	67.22	15.01	20.36	90.46
CRI	230	32.3	15.47	13.50	63.00
Firm Size	230	18.44	1.16	13.69	21.06
Interest Income	230	2.77	1.27	-0.64	9.91
NPL Ratio	230	3.40	19.41	0.02	296.00
CAR	230	13.40	4.48	8.02	54.92
ROA	230	1.96	8.12	-5.99	67.00
Equity-to-Assets Ratio	230	9.76	4.12	4.11	35.97
GDP Growth	230	6.58	0.64	5.50	7.47
Inflation	230	6.08	4.98	0.63	18.68
Deposit	230	63.39	16.10	6.64	95.17
Branchings	230	32.97	122.69	-32.68	963.00

Source: Authors' compilation result from STATA 17

4.2. The correlation between the variables in the equation

According to the Pearson correlation coefficient matrix, the research team observed that bank lending behavior has a negative correlation with bank liquidity risk (-0.223) and climate risk (-0.259) at a 10% significance level, indicating that when climate risk and bank liquidity risk increase, credit risk rises, leading commercial banks to limit lending.

Moreover, the model does not show any pairs of correlation coefficients that are too large, so there is no multicollinearity issue. Therefore, this is considered a relatively important sign in testing and selecting an appropriate model.

Table2: The Pearson correlation coefficient matrix between the variables

Source: Authors' compilation result from STATA 17

	bank_lending	bank_liquidity_risk	CRI	firm_size	interest_income	NPL_ratio	CAR	ROA	equity_to_assets	GDP_growth	inflation	deposit	branchings
bank_lending	1.0000												
bank_liquidity_risk	-0.2225*	1.0000											
CRI	-0.2592*	0.2982*	1.0000										
firm_size	0.0459	-0.0089	0.0183	1.0000									
interest_income	0.0134	-0.0609	-0.0148	0.0370	1.0000								
NPL_ratio	-0.0151	0.0847	-0.0310	0.0616	0.0238	1.0000							
CAR	-0.0548	-0.0160	-0.0213	-0.5480*	0.0578	-0.0477	1.0000						
ROA	0.1166*	-0.0478	-0.0561	0.2888*	0.0408	-0.0132	-0.1175	1.0000					
equity_to_assets	-0.1047	0.0075	-0.0049	-0.6487*	0.2126*	-0.0440	0.7279*	-0.1493*	1.0000				
GDP_growth	0.0801	-0.0523	0.0892	0.2572*	0.0292	-0.0373	-0.2445*	0.1195	-0.1865*	1.0000			
inflation	-0.1033	0.0716	-0.1882*	-0.2461*	0.1080	0.1746*	0.1578*	-0.0669	-0.1967*	-0.4587*	1.0000		

4.3. The direct effect of climate risk to bank lending behavior

The regression results show an inverse relationship between climate risk and bank lending behavior. Specifically, the estimated coefficients of climate risk in the two models, S-GMM and D-GMM, are -0.742 and -24.492, respectively, with a statistical significance level of 5%. Thus, climate risk has a negative impact on bank lending behavior, as hypothesized by the research team.

Table 3: Results of the direct impact regression

	(1) **S – GMM**	**(2)** **D – GMM**
L. bank_ lending	-0.272*** (0.112)	-0.629*** (0.237)
cri	-0.742** (0.317)	-24.492** (12.200)
GDP_growth_	-18.153 (19.894)	77.951 (120.158)
inflation	10.282*** (3.528)	-374.759* (209.283)
firm_size	15.504* (8.085)	1173.259 (932.772)
branchings	-0.061*** (0.019)	-0.123 (0.213)
interest_income	13.964** (6.656)	213.136 (184.094)
NPL_ratio	-8.434 (6.286)	295.501 (238.639)
CAR	4.367 (5.280)	-45.646 (37.919)
ROA	-4.357 (3.720)	-7.129*** (2.211)
deposit	-1.736** (0.740)	-20.996 (18.181)
equity_to_assets	-6.863 (4.389)	47.162 (70.296)
_cons	-3.674 (225.402)	
N	138	92
AR1 (p-value)		
AR2 (p-value)	0.487	0.498
Hansen-J	0.303	0.728
Chi-squared	1725.424	239.279

Standard errors in parentheses
* p<.1, ** p<.05, *** p<.01

Source: Authors' compilation result from STATA 17

4.4. The mediating role of bank liquidity risk to the relationship between climate risk and bank lending behavior

With a significant level of 1%, the estimated coefficient of bank liquidity risk in the S-GMM model is -5.458 and -1.771 in the D-GMM model, indicating that bank liquidity risk has a negative impact on bank lending behavior.

Table 4: Regression results of the impact of bank liquidity risk on bank lending behavior

	(1) S - GMM	(2) D – GMM
L. bank_ lending	-1.099***	-0.606***
	(0.359)	(0.103)
L. bank_liquidity_risk	-5.458***	-1.771***
	(1.574)	(12.200)
L. GDP_growth_	-74.658**	-17.274
	(31.083)	(11.525)
L. inflation	8.706	5.890**
	(6.117)	(2.413)
L. firm_size	-20.912	-17.888
	(26.062)	(48.291)
L. branchings	0.021	0.096***
	(0.061)	(0.024)
L.interest_income	1.137	-6.853
	(8.667)	(17.920)
L. NPL_ratio	-39.065***	-0.296**
	(12.972)	(0.150)
L. CAR	-3.892	16.147*
	(4.709)	(9.203)
L. ROA	2.697***	20.386***
	(0.936)	(6.216)
L. deposit	3.762	5.184***
	(3.096)	(1.727)
L. equity_to_assets	3.473	-12.260
	(7.410)	(7.798)
_cons	1159.988**	
	(524.786)	
N	115	161
AR1 (p-value)	0.026	0.033
AR2 (p-value)	0.152	0.244
Hansen-J	0.845	0.696
Chi-squared	2724.696	65063.520

Standard errors in parentheses
* p<.1, ** p<.05, *** p<.01

Source: Authors' compilation result from STATA 17

Table 5: Results of indirect effects

	Coefficient	OIM std. err.	z	P>|z|	[95% conf.	interval]
Structural						
bank_lending						
bank_liquidity_risk	0	(no path)				
cri	-.1743921	.0809201	-2.16	0.031	-.3329925	-.0157916
bank_liquidity_risk						
cri	0	(no path)				

Source: Authors' compilation result from STATA 17

When studying the indirect relationship between climate risk and bank lending behavior with the mediating role of bank liquidity risk, our research team found that bank liquidity risk does not alter the negative relationship between the two aforementioned variables. Specifically, through the mediating variable, the estimated coefficient of climate risk's impact on bank lending behavior remains negative (-0.174).

5. Discussion and Conclusion

From the research results, the key findings are: First, climate risk has a negative impact on bank lending behavior, and hypothesis H1 is accepted. This result is the same as the study of Faiella & Natoli (2019) and Park & Kim (2020) indicating that banks reduce the provision of credit when climate change intensifies. This indicates that commercial banks in Vietnam have recognized the consequences of climate risk in the country, which has contributed to influencing lending policies by reducing credit to prevent potential risks. Second, bank liquidity risk acts as a mediator in the inverse relationship between climate risk and the lending behavior of commercial banks. Previous research from Huang et al. (2017), Ginglinger & Moreau (2019) stated that adverse weather events or high levels of pollution can reduce the supply of loanable funds and the amount of lending by banks, increasing the liquidity risk for banks. Moreover, Merton & Bodie (1992), Ruozi & Ferrari (2013), Cornett et al. (2011) and Acharya & Mora (2015) showed that when facing liquidity risk, banks often increase lending interest rates and tighten credit standards.

To effectively respond to increasing climate risks, commercial banks need to develop an effective and comprehensive climate risk management strategy. First, banks should conduct a comprehensive assessment of their current loan portfolio, identifying high-risk loans related to sectors and regions vulnerable to climate change to limit default risks. Second, banks need to strengthen their capacity to analyze and assess climate risks, including physical risks (extreme events) and transition risks (climate policies, new technologies). Third, banks should integrate climate factors into their lending decision-making process, prioritizing green and sustainable projects and limiting lending to emission-producing sectors not only to protect the environment but also to limit credit risks and encourage businesses to pursue a green economy. Finally, banks need to develop emergency response plans to deal with unexpected climate risk situations in the short term, and in the long term, green credit policies should be developed for each bank to provide safe credit as well as protect the environment. Furthermore, the government should improve climate protection efforts, enhance the legal framework, and implement policies to mitigate climate risk, thereby creating a favorable environment for commercial banks and businesses to actively participate in the transition to a green economy.

Vietnam is a country heavily affected by climate change and has an economy that is highly dependent on agricultural production. Therefore, raising awareness to prevent climate risk is one of the measures to mitigate the vulnerability of the financial system and its potential spillover effects on Vietnam's economy.

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Sustainable Livelihood Adaptation against Climate Change for Poor Households in Ca Mau province, Vietnam

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Abstract

The study was conducted to assess livelihood vulnerability and propose sustainable livelihood strategies for poor rural households in Ca Mau due to the impacts of climate change. 150 poor households in Ca Mau were randomly selected to collect data with regard to health, food, knowledge and skills, land, properties, financial condition, etc. All of these components are analyzed through five resources identified in the sustainable livelihood's framework. The level of exposure, sensitivity, and adaptability of the indicators of livelihood vulnerability to climate change is calculated on the basis of five resources (human, nature, society, finance, and physical capital). The results of the study measured the livelihood vulnerability index in Ca Mau at 0.3528. Accordingly, the study proposes livelihood strategies for poor rural households, such as diversifying capital mobilization, strengthening linkages between scientists, farmers, and policy makers, enhancing coastal ecosystem management, and developing community livelihood.

Keywords: *Household vulnerability, Climate change, Sustainable livelihood strategies*

1. Introduction

Climate change is affecting the Mekong Delta in far-reaching ways. Impacts related to climate change are noticeable across the region and in many fields such as agriculture, infrastructure and ecosystem and others. In particular, climate change affects Ca Mau province, through more extreme weather events and natural disasters such as storms, cyclones, landslides, flooding, drought, and saline intrusion. Ca Mau is the only province affected by both the tidal regime of the East Sea and the West Sea. Sea level rise is increasing the area of inundated soils, which in turn will increase the area of salt-contaminated soil. Saline intrusion diminishes the province's freshwater agricultural ecology. In addition, extreme heat, sea level rise, and heavy rainstorms are affecting infrastructure like roads, residential areas, urban areas, and industrial zones. For the coastal areas, the landslide along the river can be caused by sea level rise.

On the other hand, climate change is thought to affect the poor and poor families. Many nearly-poor households have been reduced to poverty due to the climate change effects. First of all, the main livelihoods of poor people (farming, aquaculture and fishing) are often linked to natural resources that are vulnerable to climate change. For this reason, the poor farmers will be first affected when these resources are damaged in the context of climate change. Secondly, the abilities of poor households to recover and adapt to climate change impacts are very low. Because rural communities are highly dependent upon natural resources for their livelihoods and social structures and also have a monotonous livelihood activity, their livelihood diversification is often difficult. In particular, they often have limited resources, including financial resources and the quality of human resources.

By the end of 2016, Ca Mau province has 23,646 poor households, accounting for 7.96% of the total number of households in the province; and 11,388 nearly poor households, accounting for 3.83%. The regions in which the highest percentage of poor households exists are U Minh district with 16.78%; followed by Dam Doi district (12.8%), Tran Van Thoi district (10.03%), and Ngoc Hien district (9.35%).

In recent years, in the context of climate change, there have been a number of studies in Vietnam analyzing vulnerability in the Mekong River Delta (Oxfam, 2008; Care, 2009; WWF, 2012; Can et al., 2012; Nghi, 2016; Tuan, 2017). As for Ca Mau, there was also a study on vulnerability assessment in the context of climate change under the GIZ project in 2014 and assessing the vulnerability of climate change to the livelihoods of the coastal communities by Nguyen Quoc Nghi (Nghi, 2016). However, up to now, no specific study has assessed livelihood vulnerability and propose a sustainable livelihood strategy to adapt and reduce vulnerability to poor households in Ca Mau in the context of climate change. Therefore, this study was done.

2. Theoretical framework

Vulnerability is becoming increasingly comprehensive, and many studies have combined environmental and risk-based changes with socio-economic dimensions to determine vulnerability and the ability of community, environment and ecosystem in development. Vulnerability is not a static concept; it changes with time and space. Vulnerability to climate change depends on variation of climates and the extent to which a system is exposed, sensitive, and adaptable (IPCC, 2007). The vulnerability is "the degree to which a system is susceptible to, or cannot cope with, the adverse effects of climate change, including extremes of climate change and behavior." Vulnerability is closely related to the nature, extent and rate of climate change that a system experiences, along with the sensitivity and response capacity of that system (IPCC, 2007). The study mainly focuses on the assessment of vulnerability caused by climate change and the impacts on household economy by means of index method. Statistics are used in economics to standardize numbers and can be easily compared to different sample sizes as well as comparable to a particular standard. The vulnerability index identifies the causes of vulnerability to the system, thereby identifying a causal link between causes and outcomes, ranking and comparing lesions across regions (Fussel, 2007). An index vulnerability assessment approach aims at regulating indicators into a common indicator to compare and explain vulnerability. From the concept of the IPCC (2007), the index method is based on indicators from three components of the vulnerability: exposure levels (IPCC, 2012) - an indication of the biophysical effect, sensitivity (IPCC, 2007) and adaptive capacity (Watson et al., 1996) (sensitivity and adaptation capacity) - socioeconomic characteristics. The IPCC (2007) defines adaptive capacity as "the ability of a system to successfully adjust to climate change to reduce future losses, to take advantage of opportunities and (or) solving problems.

A system with high exposure levels and sensitivity is not necessarily called a vulnerability because both of these factors are not paying enough attention to the ability of the system to respond to climate change. In most studies on vulnerability to climate change on the household, the vulnerability index was defined as a function of exposure, sensitivity, and adaptability, with the relationship as follows: V = f (E, S, AC). Establishing vulnerability can be done in the following steps: Identifying the factors that make up the vulnerability, then identifying specific indicators. These indicators are selected based on the ability to collect data, personal findings or previous studies. Indicators are calculated so that the higher the value of the indicator is, the higher the level of vulnerability is.

Furthermore, the study uses a sustainable livelihoods framework developed by the Department for International Development – the United Kingdom (DFID) in 1999 to assess livelihood vulnerability in the context of climate change in Ca Mau, by analyzing the status of five resources of "livelihood": Finance, people, society, material and nature, in a vulnerable context (trends, seasons, climate change, etc.). A livelihood is considered sustainability when it promotes human potentials as well as the ability to overcome pressures or unexpected changes. There is a strong link between livelihood and vulnerability. Accordingly, vulnerability to livelihoods is characterized by a "no guarantee" for household living in the face of the changing external environment. Livelihoods of rural people depend on their livelihood assets, which are factors that reduce poverty through a social and institutional policies. As such, this approach is very close to the concept of multi-dimensional poverty under the Decision 59/2015/QD-TTg on multidimensional approach poverty for the period 2016-2020 in Vietnam to reflect accessibility to basic living facilities that a household needs to survive.

Based on the concept of vulnerability of IPCC (2007) and the theory of sustainable livelihoods of DFID (1999), the author develops a system of indicators assessing livelihoods caused by climate change in Ca Mau including indicators of human capital; natural capital; social capital; financial capital and property funds. Details of vulnerability indicators developed by the authors are concretized when calculating indicators for poor households in Ca Mau.

To calculate the indicator of livelihood vulnerability, the study simulates the research carried by Hahn et al. 2009; there are also changes in the major factors and sub-factors of LVI to match the condition, object and objectives of the study. The formulas are as follows:

Since the indicators are expressed in different units, the indicators will be normalized according to the following formula:

$$\text{Index}_{sw} = \frac{s_w - s_{min}}{s_{max} - s_{min}}$$

Where:

S_w: The root index represents the province w

S_{min} and S_{max}: respectively the minimum and maximum values for sub-components / metrics

After standardization, each sub-component / metric is calculated as the mean value for each of the main components as follows:

$$\text{H}_w = \frac{\sum_{i=1}^{n} index_{swi}}{n}$$

Where:

H_w: is one of the main components of the province

$index_{swi}$: represents the subcomponent

n: total number of sub-components in a main component

After calculating the major components, the next step is a weighted average of the factors (human capital, natural capital, financial capital ...). The number of dependent components has been taken as the weights to calculate the indices for the main components. The formula is as follows:

$$\text{VI (H)} = \frac{w_i H_1 + W_{ii} H_2 + \cdots w_n H_n}{w_i + w_{ii} + \cdots w_n}$$

Where:

VI (H): A weighted average of human capital

w_i; w_{ii}; w_n: number of dependent components of each major component

When the values of each major component (human capital, natural capital, social capital, financial capital, and asset capital) are calculated, it will be weighted averages Funds to obtain household livelihood damage index (LVI), according to the formula:

$$\text{LVI} = \frac{W_1 VI_H + W_2 VI_N + W_3\ VI_S + W_4 VI_F + W_5 VI_P}{W_1 + W_2 + W_3 + W_4 + W_5}$$

w_1, w_2, w_3, w_4, w5 are the number of components of human, natural, social, financial and property funds (H, N, S, F, P).

Livelihoods index (LVI) ranged from 0 to 0.6, with the least vulnerable to the most.

3. Methods

Therefore, the DFID analysis framework is consistent with the objective of the study on sustainable livelihood approach for the poor in Ca Mau in the context of climate change. The proposed analysis framework is as follows:

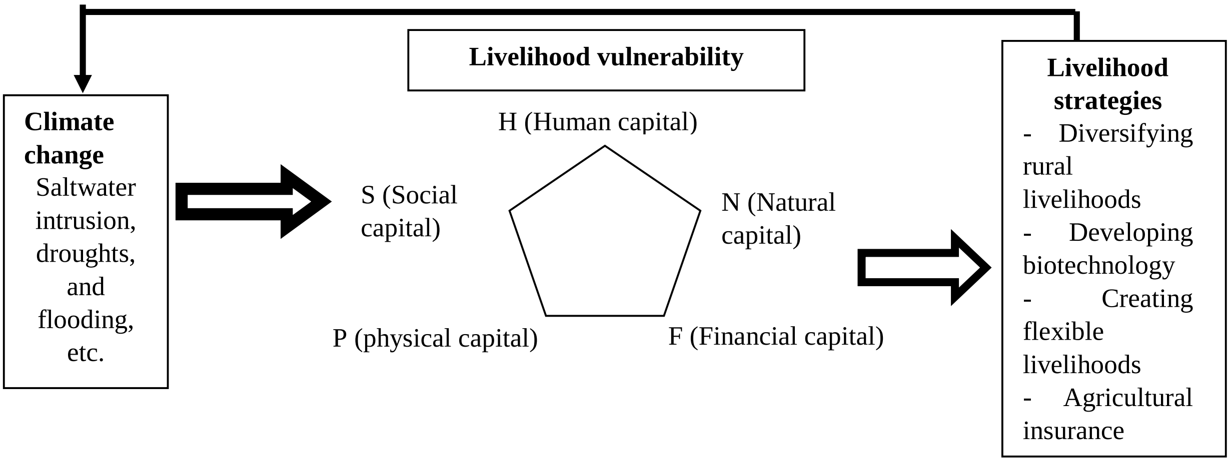

Figure 1: The author's proposed framework based on DFID (1999)

Source: DFID (1999)

The research applies both qualitative and quantitative methods including observation, group discussions, policy interviews and interviews with poor households. Two districts, Dam Doi and Ngoc Hien, were selected for the survey. Each sample was selected based on the following two criteria: (i) households living in the most vulnerable areas due to climate change; and (ii) the poorest households. In these two districts, households, especially coastal households, are inundated and eroded by waves and high tide, while the livelihoods of the poor households are small fishing and hired labor. In particular, Ngoc Hien district is separated as an island since it is bordered by the sea in the East, West, and South directions, while the North one is adjacent to Cua Lon and Bo De rivers. As a result, the district is affected by floods, saline intrusion and typhoons which make the district a vulnerable area. In Dam Doi district, there are many sources of income, but with large population, the land fund for production is reduced; thus, the vulnerability of the district is greatly increasing.

4. Results

The indicators system provided in the section 2.1 that are applied in this research to the poor household survey in Doi Ngoc and Ngoc Hien districts are to assess the livelihood vulnerability of poor households due to climate change. The detailed descriptions of the evaluation results are presented in the Table 1.

Table 1: The results of livelihood vulnerability index of poor households in Ca Mau

Capitals	Main components	Sub-components	Unit	Observation value	Max	Min	Vulnerability index
Human	Household's characteristics	Dependents	%	53.2	100	0	0.5320
		Female head of the households	%	13.4	100	0	0.1340
	Vulnerability index on households' characteristics						**0.3330**
	Health	Family members with chronic diseases	%	2.13	100	0	0.0213
		Households in need of healthcare/ medical support	%	1.58	100	0	0.0158
		Days in hospitals for treatment	Days/ Years	4.0	360	0	0.0110
	Health vulnerability index						**0.0160**
	Food	Food shortage	%	8.0	100	0	0.08
		Households without crop diversification	%	34.3	100	0	0.343

	Food vulnerability index						**0.2115**
	Vulnerable livelihoods' strategies	Households without livelihood diversifications	%	45.8	100	0	0.458
		Households earning a living out of farming	%	67.2	100	0	0.672
		Households with stable incomes	%	73.4	100	0	0.734
		Households with members working in non-agricultural sections	%	32.8	100	0	0.328
		Unemployment months	Months	3	12	0	0.250
	Vulnerable livelihoods' strategy index						**0.4884**
	Knowledge and skills	Heads of households with primary education	%	58.6	100	0	0.586
		Households not participating workshops on adaptation to climate change	%	87.2	100	0	0.872
		Households with all members participating in the training workshops	%	92.1	100	0	0.921
	Vulnerability index on knowledge and skills						**0.793**
Weighted average of human capital (H): Vulnerability about H							**0.3972**
Natural	Land	Households without agricultural land	%	24.2	100	0	0.342
		Households with a piece of agricultural land	%	25.1	100	0	0.251
		Households with uncultivated land due to climate change	%	38.2	100	0	0.382
		Households losing land due to climate change	%	4.12	100	0	0.0412
	Vulnerability index on land						**0.254**
		Households in shortage of clean water	%	62.1	100	0	0.621
		Households with a lack of fresh water	%	9.12	100	0	0.0912
	Vulnerability index on water sources						**0.356**
	Forests and other natural resources	Households dependent on forest resources	%	25.2	100	0	0.252
		Households assuming forest resources are becoming scarce.	%	87.6	100	0	0.876
		Households assuming other natural resources are becoming drained.	%	78.3	100	0	0.783
	Vulnerability index on forest resources						**0.637**
	Climate change	Average times of flooding in the past 5 years	Quantities	04	10	0	0.400
		Households with soil erosion	%	14.2	100	0	0.142

		Households assuming changes of annual rainfall and saltwater intrusion are affecting their lives.	%	58.3	100	0	0.583
		Households not being notified of impacts of climate change to their livelihoods.	%	41.6	100	0	0.416
	Vulnerability index on climate change						**0.385**
Vulnerability index on natural capital (N): Vulnerability on N							**0.398**
Social	Social networks	Households not being supported	%	17.4	100	0	0.174
		Households with members having no social interactions	%	6.73	100	0	0.0673
		Households not coming to the local government for any assistance in a year	%	7.17	100	0	0.0717
Vulnerability index on social capital (S): Vulnerability on S							**0.104**
Financi al	Income and finance	Households with credit loans	%	59.9	100	0	0.599
		Households subsidized with finance	%	17.3	100	0	0.173
		Households not being able to access to financial services	%	38.1	100	0	0.381
		Households with no income generated from agricultural. fishery and forestry activities due to climate change	%	7.12	100	0	0.0712
Vulnerability index on financial capital (F): Vulnerability on F							**0.304**
Properti es	Production facilities and housing	Households with temporary housing	%	23.1	100	0	0.231
		Households with housing affected by climate change	%	13.2	100	0	0.132
		Households with no production facilities	%	52.7	100	0	0.527
		Households with cultivating affected by climate change	%	28.2	100	0	0.282
Vulnerability index on properties (P): Vulnerability on P							**0.293**
Livelihood Vulnerability Index (Weighted average of H. N. S. P. F)							**0.3528**

Source: Authors' computation

The results of the study show that the livelihood vulnerability index of poor households in Ca Mau is 0.3528, which indicates the average vulnerability of livelihoods. The value of the main components ranges from 0.1 to 0.4. In particular, natural capital and human capital are the most vulnerable.

Major components of human capital such as knowledge, skills and livelihood strategies have the highest vulnerability index, 0.793 and 0.488, respectively. This is because the majority of poor households are dependent on risky resources, so they do not have a fixed source of income. In addition, the percentage of households with a low level of education is very high, with a very high proportion of poor households not participating in training workshops for adapting to climate change.

Major components of natural capital have very high vulnerability indexes such as forests and other resources (0.637) and climate change (0.385). Land and forest resources are important natural resources for smallholder farmers. However, for poor households, the land for agricultural productions is very small. Many households do not have land for their livelihood, while forest resources are increasingly scarce. Many poor households in Dat Mui commune, Ngoc Hien district have no access to forest resources, leading to reduced incomes and increasing vulnerabilities. Moreover, in recent years, sea level rise has caused difficulties in catching aquatic products, damage to property and livestock. In some coastal areas, because of the risk of being exposed to flooding, salinity intrusion, the impact of storms, large-scale rain, erosion, and tornadoes, the level of vulnerability will be greater in the future.

Financial capital is also worth considering with a 0.304 vulnerability index, especially in the context of the current economy. Because of their inability to accumulate, and with limited access to credit capitals, poor households often lack the funds to secure the livelihood strategies they pursue. Moreover, the rate of poor households prioritizing the use of loans to solve immediate difficulties as well as for the minimum needs is very high; therefore, there will definitely be little to no investment spent on production, which leads to the lower production efficiency.

In addition to the above-mentioned funds, the results of the livelihood vulnerability assessment in Table 1 also show that social capital and property capital have lower vulnerability indexes. This may be due to the fact that households have more connections with the community to gain access to care, sharing and learning experiences. A large number of poor households have participated in local associations such as the Farmers' Association and the Women's Union, accounting for 45.3% of the surveyed households. At the same time, local authorities have also paid attention to the living conditions of poor households. The electricity, water supply and transport systems have made significant positive changes in livelihood improvement and sustainable poverty reduction.

5. Discussion and Policy Implications

For human capital

Among the sub-components of the Human capitals, the index on knowledge and skills have made an integral contribution toward the more increasing vulnerability for the poor. In fact, although there have been hundreds of workshops about adaptation to climate change organized for years by the cooperation among scientists and government, still great number of households have refused to get the benefit (up to 87.2%) because of two main reasons. The first is the effects of climate change have gradually come with little physical evidence year by year so farmers thought that their attendance would be a waste of time. The second is the farmers’ presence in those workshops were not compulsory for all of them. As a result, with lack of the perception of fact and the suitable resilience method against the negative changes in climate, they keep destroying mangrove forest which is also the protection from sea intrusion for farming purposes. Therefore, awareness, education and propagandas on climate change should be broadened in more effective ways such that those who do attend the workshop will be given the most priority from bank’s loan and other governmental financial supports. Aside from inactively being trained in workshop, farmers’ mindset about climate change must be refreshed through local radio publicizing climate change issues. Improving the quality of human capital through promoting vocational training for the poor in the dynamic direction. Successful stories right in their own area are to be shared to attract other farmers’ attention as output is increased with less effort than the old means when following the new technique. In order to the training more advantageous and interesting to farmers. Besides the temporary solutions, there must be long-lasting plans for educating the local people. They are integrating climate change into school as an official course even in kindergarten and primary school, also educational practices should be combined in study programs and syllabus; encouraging the development of networks and cooperation on climate change education. Investment in education is the most central issue that the province must focus on. As a matter of fact, a large number of people in Cau Mau are living with stable income (73.4%) but they still fall into vulnerability of livelihoods’ zone. This fact proves that stable income does not make much sense because of their inherent habits of living of not taking care the sustainable future. Gradually changing their attitudes must be done from now on through education at the young ages.

For financial capital

Establishing a diversified fund managed by a board of delegates from local government and farmers' Union. The fund must be mobilized from various capital sources, including state budget funds, capitals from organizations and individuals for investment purposes on farmers. The operating mechanism of the fund has their own mission, plans for short-term climate change's resilience, and strategies for long-term climate change's adaptation. Farmers who seriously take part in climate change programs will be assessed as high commitment to be received favorable endowments from the fund. Credit loans provided by the fund should be operated in a flexible way with regard to loan amounts, formalities, procedures and duration. Besides, there must be periodic supervisions to ensure whether the money is effectively used in the right way in order for the decision of keeping granting them. Specifically, part of the fund will definitely be invested in the purchases of needed production materials during the program while the the rest is used only to support the farming such as fertilizers, seedlings and other related expenses rather than to the daily living activities. What is more, there should be included specific instructions for effective planting stages, this is a kind of business plan instead of giving away the money and leaving the farmers with nowhere to go with a lum sum endowment. It is essential to create favorable conditions for poor households to access other preferential credit programs such as pupils and students, housing for poor households and clean water in order to create conditions for poor households to settle difficulties in the lack of education, clean water, and environmental sanitation.

For physical capital

Poor households with less farming land, equipment and tools need to be consulted and supported to apply land saving models, progress efficiency of using land by producing modern production methods. It is also important for the poor to produce more products and improve production value to increase income and have a chance to escape poverty sustainably. For those poor households without farming land, it is recommended to get employment counseling and change to appropriate occupations to generate income. For poor coastal households specializing in small, near-shore fishing, and the province should provide support to these households for loans to invest in buying fishing gear to improve fishing efficiency. Additionally, the province needs to build the necessary infrastructure to facilitate travel for people in the area, including poor people, which will contribute to the development of local economy.

The issue of mitigation of climate change is not really received much attention from various stakeholders due to the financial constraints (investment cost for technology and related risks). The new market of green technology and the lack of infrastructure have not met the requirements, and accordingly, local people have difficulties in accessing clean energy sources. Information system about the potential mitigation is not complete and accurate; therefore, the province needs to increase investment in infrastructure as well as green technology.

For natural capital

Reinforcing the management of community-based mangrove forest resource: The mangrove forest ecosystem is a very important resource and a source of benefits for the poor whose livelihoods are dependent on nature. The planting and protection of mangroves in Ca Mau Province needs special attention. Mangrove management requires active involvement of local communities through the efficient operation of farmers and Mangroves Management Board elected by local people. Land use planning activities also require active involvement of the community in all areas, together with local authorities and stakeholders. Spreading the model of shrimp farming under the mangrove to as many farmers as possible. Farmers who do not own cultivated land and production facilities assessed to be highly vulnerable. Consequently, in order to ensure the demand for living, farmers have no way to destroy mangrove forest ecology by fishing near the shore. The problem can be solved by a program designed for the transition to other livelihoods that no longer heavily depend on natural capital. The program can be effectively carried out in the connection with government poverty reduction programs.

For social capital

Building and developing models of economics adapting to climate change such as:

Marine ecosystem co-management model: Creating mechanisms and methods to promote people, authorities and stakeholders to exploit and benefit from the marine ecosystems, as well as to protect and develop those sources of great benefits in a sustainable way.

Sustainable community-based fishing and aquaculture model: Supporting fishermen to exploit or cultivate aquatic products in an eco-friendly manner with the ability to adapt to climate change and with planning that do no harm to sea ecology and marine resources.

Coastal ecotourism is a way to diversify livelihoods, to increase incomes for coastal people and reduce the pressure on direct exploitation of marine ecological resources through ecotourism development at the local areas, in which the local people provide and manage the services.

Establishing the connections between the state government, enterprises and poor farmers: The province and districts should build appropriate infrastructure to create favorable conditions for farmers to produce commodities with comparative advantages; The State and enterprises should not only determine the market for each key product of the local but also build a "High-tech Agricultural Production Complex" that is capable of creating branded products; Agricultural insurance is a very meaningful program for poor farmers in agriculture and is of great significance in adaptation to climate change in Ca Mau; for the poor households, it is necessary to strengthen the environmental protection, and at the same time, there should be forms of support and incentive forms of agricultural insurance in the context of climate change so that poor households are assured of producing and developing their livelihoods.

Integrate disaster risk reduction and climate change adaptation into the socio-economic development plan of the district and province through: Situation analysis, finding solutions and identifying priorities related to climate change and adapting to climate change for socio-economic development; and consulting and getting feedbacks from the people, which ensures the broad participation, contribution and support of the people and relevant departments.

6. Conclusion

Climate change has been affecting almost all areas, constraining local, regional or national socio-economic development as well as hindering human development. Vulnerability assessments of different regions or sectors for the impacts of climate change are the basis for policy makers to have appropriate adaptation measures in each of these areas as well as for the community to have adaptive measures for themselves. Vulnerability assessment by means of index is an effective method to translate qualitative elements into quantitative elements. This paper presents a quantitative method of vulnerability assessment using the vulnerability index method. Research results show that climate change has caused damage to poor households in Ca Mau. This has provided further evidence for examining the vulnerability caused by climate change of poor households in Ca Mau. The vulnerability index of poor households in Ca Mau is 0.3528, indicating that the vulnerability of the poor households is not too high, only average. However, the vulnerability index of human capital and natural capital is relatively high, with most of the major components such as livelihood strategies, knowledge and skills of poor households, forest and other natural resources. In order to ensure sustainable livelihoods for poor Ca Mau households, there should be close coordination among local authorities, supportive organizations and poor households themselves. Comprehensive solutions from resource extraction, resource efficiency and other sources of livelihoods should be implemented in a step-by-step manner to improve the quality of human capital as well as diversify livelihoods to reduce sustainable poverty.

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Promoting Green Public Governance Towards Net Zero Emissions Goal in Vietnam and Taiwan

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Abstract

This research focuses on the crucial role of green public governance in achieving the net zero emission target. The article emphasizes that climate change and the depletion of natural resources are threatening global sustainable development, requiring strong participation from both governments and businesses in implementing green public governance measures. The research methodology includes secondary data analysis, statistics, comparisons, and literature review from various reputable academic sources. Data were collected from official reports and scientific literature on environmental policies of Vietnam and Taiwan. The research findings indicate that both Vietnam and Taiwan have developed policies and legislation to support green public governance, but Vietnam faces numerous challenges in implementation, particularly due to a lack of resources and technical capacity. Meanwhile, Taiwan has achieved significant success thanks to a more robust and coherent legal framework. The paper concludes that green public governance is not only a necessary tool for emission reduction but also a long-term strategy to guide these nations towards sustainable development.

Keywords: *Climate change, environmental policy, Net-zero emission, green public governance, sustainable growth*

1. Introduction

With the rapid increase in greenhouse gas emissions, climate change has become one of the greatest challenges facing humanity. According to the United Nations Climate Change Assessment Report (2023), global temperatures have risen by approximately 1.2°C above pre-industrial levels and are projected to rise to 1.5°C within the next two decades if strong emission reduction measures are not taken. Excessive use of natural resources has led to the rapid depletion of many resource reserves. According to the United Nations Environment Programme's World Resources Report (2023), if the current consumption trends continue, the world will need the resources of three Earths to sustain living standards by 2050.

Environmental pollution, especially air and water pollution, causes numerous health problems for humans. The World Health Organization (WHO) estimates that outdoor air pollution accounts for approximately 4.2 million deaths globally each year.

To achieve economic development without harming the environment, green public governance is a key factor. It helps balance economic growth and environmental protection, ensuring that resources are used sustainably. The World Bank's (2022) report shows that sustainable development measures could create an additional 20 million jobs worldwide.

2. Theoretical framework

2.1. Public governance, green public governance, Net Zero emissions

2.1.1. Public governance

To date, public governance remains a complex and difficult term to define, as it involves various fields within science, society, humanities, and political science (Hadj Fraj et al., 2018). According to Kaufmann & Kraay (2002), public governance can be viewed as the government's ability to control resources, respect property rights, and ensure the efficiency of public services. Public governance also promotes policies, regulations, and the establishment of institutions to manage the relationship between the economy and society.

The World Bank's 2017 Economic Development Report defines public governance as the process of interaction between entities within and outside the government to design and implement policies within a set of formal and informal rules that shape and are shaped by power. This power is seen as the ability of groups and individuals to influence others to act in their interest to achieve specific goals.

2.1.2. Green public governance

Green public governance is understood as the way governments establish and implement regulations to improve resource efficiency in the public sector. It involves reducing plastic production, implementing "green" public procurement, and minimizing non-recyclable waste (Pogodina et al., 2019).

According to Ndukwe et al. (2023), green public governance not only involves setting rules to ensure that economic entities comply with "greening" practices, but also requires responsible consumption within the public sector itself, leading the way in convincing other economic sectors of the necessity to reduce human impact on the environment.

2.1.3. Net Zero emissions

Net zero emissions (Net Zero) is a relatively new concept for many people, but it is an inevitable trend for sustainable development. Net Zero is a scientific concept implying that there is a finite amount of carbon dioxide that can be released into the atmosphere, along with other greenhouse gases (Fankhauser et al., 2022). In other words, Net Zero is understood as reducing greenhouse gas emissions to nearly zero, with the remaining emissions being reabsorbed from the atmosphere by forests and oceans.

The green transition journey of the economy and business environment in Vietnam and Taiwan is not an easy one, but it is hoped to be a bright one. To successfully achieve the Net Zero target, the role of green public governance in enterprises is crucial, providing a fundamental, systematic, and comprehensive solution.

2.2. The relationship between green public governance and the Net Zero emissions goal

Green Public Governance as a Foundation: To achieve the goal of Net Zero emissions, green public governance plays a crucial role. Policies and measures within green public governance, such as increasing the use of renewable energy, improving energy efficiency, and promoting sustainable production and consumption, all directly contribute to reducing greenhouse gas emissions. According to the International Energy Agency (IEA) report (2023), improving energy efficiency could reduce 40% of the global emissions needed to achieve the Net Zero target.

Systemic Transformation: Green public governance requires a systemic change in the entire economic framework, from production and consumption to resource management. This includes adopting new technologies, changing human behavior and lifestyles, and developing strong supportive policies from the government. The World Economic Forum (2023) suggests that transitioning to a green economy could increase global GDP by 0.4% annually.

Global Commitment: Achieving the Net Zero emissions goal requires not only the efforts of individual countries but also international cooperation. Green public governance fosters this cooperation through the sharing of knowledge, technology, and resources. The United Nations Environment Programme (UNEP) emphasizes that international collaboration is key to achieving sustainable goals and mitigating the impacts of climate change.

Green public governance is not just a concept but a mandatory direction to protect the planet and ensure a sustainable future for future generations.

3. Methods

To clarify data collection and processing in the paper, the author applied the following research methods.

Literature Review: The author conducted a literature review to gather and synthesize information from sources such as Google Scholar, academic databases like SpringerLink, ScienceDirect, Wiley Online Library, and specialized journals.

Secondary Data Analysis: The author utilized existing data from secondary sources, including research reports, government documents, and prior studies to support the analysis.

Statistics: Statistical tools and methods were used to analyze and clarify the collected data, aiming to draw valuable conclusions for the research.

Comparison: The comparison method was applied to contrast and analyze the differences and similarities between studies and data from different countries.

These methods help systematize the literature, build on results from previous studies, and provide a comprehensive view of the research topic.

4. Results

4.1. Current state of green public governance in Vietnam and Taiwan toward the Net Zero emissions goal

4.1.1. Context in Vietnam and Taiwan

The greenhouse gas emissions situation between Vietnam and Taiwan reflects significant differences, highlighting the varying levels of economic development and environmental policies of the two regions.

Development Level: Vietnam is one of the fastest-growing countries in Southeast Asia, which has resulted in higher greenhouse gas emissions (Vietnam Ministry of Natural Resources and Environment, 2023). In contrast, Taiwan, with its well-established industrial economy, has likely been better equipped to manage emissions issues (Taiwan Environmental Protection Agency, 2023).

Total Greenhouse Gas Emissions in 2022: Vietnam recorded a total greenhouse gas emission of 321 million tons of CO2 equivalent, an increase of about 5.3% compared to 2021 (Vietnam Ministry of Natural Resources and Environment, 2023). Conversely, Taiwan reported total emissions of 274 million tons of CO2 equivalent, a 1.2% decrease from the previous year (Taiwan Environmental Protection Agency, 2023). The rise in emissions in Vietnam may be attributed to rapid development and industrial growth, whereas Taiwan has achieved success in reducing emissions through effective environmental management policies.

Main Emission Sources: In Vietnam, the primary emission sources are the energy sector, accounting for about 60% of total emissions, along with agriculture, forestry, and other industries (Vietnam Ministry of Natural Resources and Environment, 2023). Taiwan, meanwhile, faces emissions primarily from the industrial and energy sectors, which make up over 70% of total emissions (Taiwan Environmental Protection Agency, 2023). This indicates that Vietnam is dealing with multiple emission sources, whereas Taiwan focuses more on heavy industries.

Control Measures: Taiwan has implemented emission control measures and increased the use of renewable energy, reflecting a strong emphasis on environmental protection and sustainable development (Taiwan Environmental Protection Agency, 2023). In contrast, Vietnam has yet to provide specific information on greenhouse gas control measures, indicating a need for clearer and more effective environmental protection policies (Vietnam Ministry of Natural Resources and Environment, 2023).

4.1.2. Green public governance in Vietnam

4.1.2.1. Policies and laws related to green public governance in Vietnam

Vietnam has developed a relatively comprehensive legal framework to support green public governance. However, challenges remain in implementation due to resource constraints and a lack of policy coherence. There is a need for improvements in resource mobilization and enforcement capacity to achieve sustainable goals. Below is a summary table of key policies and laws related to green public governance in Vietnam. These regulations serve as the foundation for environmental management and the promotion of sustainable development (Table 1).

Table 1: Policies and Laws Related to Green Public Governance in Vietnam

STT	Policy/Law	Main Content	Reference
1	Environmental Protection Law (Revised 2020)	The main legal framework for environmental management, including environmental impact assessment, waste management, natural resource protection, and climate change response.	Environmental Protection Law (Revised 2020)
2	National Strategy on Green Growth (2012)	Promotes sustainable economic growth, aiming to reduce greenhouse gas emission intensity by 8-10% compared to 2010 levels, increase the use of renewable energy to 15-20% by 2030, and reduce energy consumption per GDP by at least 1.5% per year.	National Strategy on Green Growth 2012
3	National Action Plan on Climate Change (NAP-CC)	Aims to reduce total greenhouse gas emissions by 9% by 2030, strengthen climate change adaptation across all economic and social sectors, and improve disaster risk management.	NAP-CC 2020
4	Renewable Energy Development Plan	Provides guidance for the development of renewable energy, targeting 32% of total installed capacity by 2030, with a projected total investment of $30 billion.	Renewable Energy Development Plan
5	Water Resources Law (2012)	Manages, protects, and sustainably uses water resources. Ensures efficient use, prevents pollution and depletion of water sources, and enhances freshwater reserves for production and domestic use.	Water Resources Law (2012)
6	Decree No. 40/2019/ND-CP on GHG Inventory, Reporting, and Verification	Specifies measures to reduce greenhouse gas emissions, requiring annual reporting by businesses, and verification by competent authorities.	Decree 40/2019/ND-CP

Source: Compiled by the author

4.1.2.2. Challenges and opportunities in implementing these policies in Vietnam

Vietnam faces several major challenges in implementing green public governance policies, including a lack of resources and policy consistency. However, there are also many opportunities arising from international commitments and support that can help improve the situation. Below is a table analyzing the challenges and opportunities that Vietnam faces in implementing green public governance policies. Identifying these factors is essential for developing more effective strategies (Table 2).

Table 2: Challenges and opportunities in implementing green policies in Vietnam

Challenges	Opportunities	References
Lack of financial and technical resources. High costs for environmental protection measures (estimated at around USD 30 billion by 2030).	International Commitments: Vietnam has committed to an 8% reduction in greenhouse gas emissions with international support, which could increase to 25% with financial and technological assistance from abroad.	Vietnam's Commitments at COP26, 2023
Limited enforcement capacity, lack of specialized personnel and technology to implement green policies.	International Support: Opportunity to receive assistance from international organizations such as the World Bank, UNDP, and ADB to develop green projects.	UNDP Support for Green Policies in Vietnam, 2022
Conflict between short-term economic interests and environmental protection, especially in heavy industries.	Increasing Public Awareness: More businesses and citizens are becoming aware of the importance of sustainable development.	Climate Change Awareness in Vietnam, 2023

Challenges	Opportunities	References
Lack of policy and regulatory coherence, leading to difficulties in consistent implementation.	Green Technology Development: Vietnam has the potential to develop green technologies, with investment from both foreign and domestic sources in renewable energy, waste management, and sustainable development projects.	Green Technology Development in Vietnam, 2023

Source: Compiled by the author

4.1.2.3. The status of Vietnamese businesses and organizations in implementing public green governance

Although an increasing number of businesses are aware of and committed to implementing green governance, the adoption rate of green technologies remains low, particularly among small and medium-sized enterprises. Financial difficulties and lack of government support are major barriers that need to be addressed. The following provides information on the current status of green governance implementation within businesses and organizations in Vietnam, along with the challenges they face (Table 3).

Table 3: The status of businesses and organizations in implementing public green governance in Vietnam

Criteria	Key Content	References
Awareness and Commitment	According to a VCCI survey in 2022, 65% of businesses are aware of the importance of sustainable development, but only 35% are committed to implementing it.	VCCI 2022 Survey on Sustainable Development
Internal Policies	Nestlé Vietnam has issued internal policies aiming for "Net Zero" by 2050, reducing water consumption by 50% in production, and reusing 100% of packaging.	Nestlé Vietnam Report 2022
Green Technology and Production Processes	Only about 20% of businesses adopt green technologies in production, mainly in the textiles, food processing, and renewable energy sectors.	CIEM 2023 Report on Green Technology
Difficulties and Challenges	According to the WB report, businesses face difficulties in accessing green finance and lack technical and financial support from the government.	WB Report 2023

Source: Compiled by the author

4.1.3. Green public governance in Taiwan

4.1.3.1. Policies and legislation related to green public governance in Taiwan

Taiwan has established a solid and coherent legal framework for green public governance. These policies strongly support green initiatives, but there are still some challenges in implementation and oversight. Below is a summary table of key policies and legal frameworks in green public governance in Taiwan. These regulations provide a foundation for the development of green technology and environmental protection (Table 4).

Table 4: Policies and legal frameworks related to green public governance in Taiwan

No.	Policy/Legislation	Main Content	References
1	Environmental Protection Act	Enacted in 1975, this law requires businesses to periodically report on pollution mitigation measures and improvements in environmental quality.	Taiwan Environmental Protection Act, 2023
2	Renewable Energy Development Plan	Taiwan aims to achieve 25% renewable energy by 2025, with significant investments in wind and solar power.	Taiwan Renewable Energy Development Plan, 2023

No.	Policy/Legislation	Main Content	References
3	Green Growth Program	Taiwan is committed to reducing greenhouse gas emissions by 20% by 2030 and developing a green economy based on technological innovation and sustainable consumption.	Taiwan Green Growth Program, 2023
4	Water Resources Management Act	Ensures sustainable water use, protects water resources, and effectively manages industrial wastewater treatment.	Taiwan Water Resources Management Act, 2023

Source: Compiled by the author

4.1.3.2. Challenges and opportunities in implementing these policies in Taiwan

Although Taiwan has made significant progress in implementing green public governance policies, some challenges remain, including maintaining a balance between economic development and environmental protection. Strengthening green initiatives and improving management practices are essential to achieving sustainable development goals. Below is a table summarizing the current state and challenges in implementing green public governance in Taiwan. It reflects the progress and issues that need to be addressed to achieve sustainable development goals (Table 5).

Table 5: Challenges and opportunities in implementing green policies in Taiwan

Challenges	Opportunities	References
Limited natural resources, particularly land and water.	Taiwan has a well-developed education and scientific research system, which fosters innovation in green technology and renewable energy.	Taiwan Green Growth Program, 2023
Dependence on imported energy and raw materials.	Opportunities to develop renewable energy projects such as wind and solar power, thanks to favorable climatic conditions.	Taiwan Renewable Energy Development Plan, 2023
High costs of transitioning to a green economy, especially for small and medium-sized enterprises.	Support from the government and international organizations, such as ADB and WB, to develop green projects and energy-saving initiatives.	ADB Supports Taiwan’s Green Finance, 2023
International competition pressure, particularly from China, with lower production costs.	Enhancing Taiwan's international image as a green and sustainably developing nation.	Taiwan’s Global Leadership in Green Technology, 2023

Source: Compiled by the author

4.1.3.3. The current state of taiwanese enterprises and organizations in implementing green governance

Large enterprises in Taiwan have effectively implemented green governance measures and invested in green technology, but the adoption is not uniform, especially among small and medium-sized enterprises. Increased awareness and supportive government policies have helped promote green governance; however, there is still a need for improved support and implementation. Below is a table presenting the current state of enterprises and organizations in Taiwan regarding the implementation of green governance. This information helps assess the level of commitment and the challenges that businesses face in applying environmental protection measures and sustainable development (Table 6).

Table 6: The current state of enterprises and organizations in implementing green governance in Taiwan

Criteria	Key content	References
Awareness and Commitment	Approximately 70% of Taiwanese enterprises recognize the importance of green governance, particularly in the high-tech and manufacturing sectors.	Taiwan Environmental Awareness Report 2022
Internal Policies	TSMC, one of Taiwan's largest technology corporations, is committed to reducing 100% of industrial wastewater and achieving "Net Zero" by 2050.	TSMC Sustainability Report 2022
Green Technology and Production Processes	About 35% of enterprises have invested in green production technology, focusing on the electronics, machinery manufacturing, and renewable energy sectors.	Green Manufacturing in Taiwan
Challenges	High investment costs in green technology and intense competition from neighboring countries reduce the competitiveness of Taiwanese enterprises.	WB Report on Green Challenges in Taiwan

Source: Compiled by the author

4.2. Comparison, lessons learned, and proposed solutions to enhance green governance effectiveness in Vietnam and Taiwan

4.2.1. Comparison

Although both Vietnam and Taiwan aim for sustainable development and the adoption of green technology, Taiwan has established a more robust legal framework and practical implementation. Vietnam is still in the process of improvement and needs to enhance various aspects, particularly in financial support and training. Below is a table summarizing the similarities and differences between Vietnam and Taiwan in green governance policies and practices (Table 7). This table provides an overview of the commonalities and distinctions between Vietnam and Taiwan in implementing green governance. The information helps identify areas that require improvement and highlights strengths that can be learned from the counterpart.

Table 7: Comparison of similarities and differences in green governance policies and practices between Vietnam and Taiwan

No.	Comparison	Content	References
1	Policies and Legal Framework	Similarities: Both Vietnam and Taiwan focus on environmental protection and sustainable development, with commitments to reducing greenhouse gas emissions and increasing the use of renewable energy. Differences: Taiwan has a more complete legal framework; Vietnam is still in the process of refining and implementing policies with some regulations not fully developed. Financial Support: Taiwan offers more financial incentives, while Vietnam provides limited support for small and medium-sized enterprises.	Vietnam Ministry of Natural Resources and Environment, 2024; Taiwan Ministry of Economic Affairs, 2023; Taiwan Environmental Protection Administration, 2023; World Bank, 2023
2	Practical Implementation	Similarities: Both Vietnam and Taiwan emphasize green technology and improving production processes to reduce environmental impact. Large enterprises are investing in green technology solutions. Differences: Taiwan more widely adopts green technology and	Vietnam Ministry of Natural Resources and Environment, 2024; Taiwan Economic Research Institute, 2023; Taiwan Development

No.	Comparison	Content	References
		environmental protection measures; Vietnam is still in the early stages and faces many challenges, especially for small and medium-sized enterprises. Awareness and Education: Taiwan has educational and training programs on green governance, while Vietnam is more limited in this area.	Research Institute, 2023; Taiwan Chamber of Commerce, 2023

Source: Compiled by the author

4.2.2. Lessons learned between Vietnam and Taiwan

From Taiwan to Vietnam

Policy Experience: Vietnam can learn from Taiwan in developing and implementing green governance policies. Taiwan has established a comprehensive and cohesive legal framework, including specific regulations and effective enforcement mechanisms. Vietnam could apply these lessons to enhance its own policies and regulations, from setting environmental standards to monitoring and enforcing compliance. For example, Taiwan has set high standards for air quality and waste management, which Vietnam could use as a reference for creating similar systems.

Financial Support and Incentives: Taiwan has implemented various financial support programs and incentives to encourage businesses to adopt green technologies, including grants, tax credits, and other forms of support. Vietnam should consider implementing similar measures to reduce the financial burden on businesses and promote the adoption of green technologies. For instance, providing preferential loans or tax reductions for renewable energy projects could help lower investment costs for businesses and encourage the development of green technology.

From Vietnam to Taiwan

Awareness and Education: Taiwan could learn from Vietnam's approach to developing effective education and training programs for small and medium-sized enterprises (SMEs). Vietnam has implemented numerous training programs to raise awareness about green governance and enhance the ability of businesses to apply sustainable solutions. Taiwan could adopt these methods to strengthen training for its own businesses, thereby increasing understanding and the ability to implement green governance practices. For example, training programs on energy efficiency and waste management could help businesses in Taiwan improve their operational effectiveness.

Sustainable Development Strategies: Vietnam could share its experience in building and implementing long-term sustainable development strategies, particularly in areas where Taiwan might be facing challenges. One such area could be improving energy efficiency in heavy industries. Vietnam has undertaken several initiatives to enhance technology and production processes to reduce energy consumption and pollution. Taiwan could apply these experiences to address similar challenges, such as optimizing industrial production processes to lower energy consumption and greenhouse gas emissions.

4.2.3. General policy and strategic cooperation proposals between Vietnam and Taiwan

<u>Group 1: Proposals for policies and cooperation between Vietnam and Taiwan</u>

First: Establishing a joint framework for green governance:

Creating a cooperation mechanism: Establish a cooperation mechanism between the two economies to exchange information, experiences, and best practices in green governance. This mechanism could involve setting up a joint working group on green governance to evaluate and propose policies.

Developing cooperative programs: Encourage the development of collaborative programs in green technology research and development. The two sides could cooperate on joint research projects and pilot new green technology solutions.

Second: Enhancing experience sharing and training

Organizing seminars and training sessions: Conduct joint seminars and training sessions to raise awareness and knowledge about green governance. These events could focus on topics such as environmental policies, green technology, and best practices in green governance.

Sharing best practices: Facilitate the sharing of best practices between businesses and organizations in Vietnam and Taiwan on the adoption of green technology and environmental protection. This exchange could be conducted through online forums, research reports, and expert networks.

Third: Supporting and encouraging investment

Establishing a green investment support fund: Create a green investment support fund for green technology businesses and projects in Vietnam and Taiwan. This fund could offer preferential loans, grants, and financial support for environmental protection and sustainable development projects.

Encouraging cross-investment: Promote cross-investment between the two economies in green technology and renewable energy sectors. Investment incentives and public-private partnerships could facilitate the involvement of businesses from both sides in green technology projects.

<u>Group 2: Solutions to enhance international and regional cooperation in promoting green governance</u>

First: Participating in international and regional initiatives

Engaging in international environmental organizations: Participate and contribute to international organizations such as the United Nations, the World Bank, and environmental NGOs. This participation will help Vietnam and Taiwan access global resources, technology, and knowledge on green governance.

Regional cooperation: Strengthen cooperation with countries in Southeast Asia and East Asia to promote green governance initiatives. Regional cooperation could include joint projects, information sharing, and organizing conferences on green governance.

Second: Developing innovation and technical support programs

Building innovation programs: Develop and implement green technology innovation programs which could involve supporting research and development, piloting green technologies, and deploying sustainable solutions.

Providing technical and financial support: Offer technical and financial support to developing countries in the region to help them implement green governance solutions. This support could include training, consulting, and providing advanced technologies.

Third: Promoting cooperation and innovation

Encouraging cooperative spirit: Motivate businesses and organizations in the region to participate in cooperative projects and share experiences in green governance. These initiatives could help create new business models and enhance the adoption of green technologies.

Developing effective public-private partnership models: Develop effective public-private partnership models to implement environmental protection and sustainable development projects. These models could help increase private sector involvement and ensure the necessary resources for green projects.

5. Conclusion

Green governance is a crucial factor in sustainable development and environmental protection, encompassing policies and practices aimed at reducing the negative impacts of industry and business. Analysis shows that both Vietnam and Taiwan have implemented green governance policies, but Taiwan has a more consistent legal framework, while Vietnam is still in the process of refining its policies. Taiwan has been successful in adopting green technologies, whereas Vietnam faces many challenges, especially with small and medium-sized enterprises. Cooperation in training, financial support, and technical innovation is essential to improve the effectiveness of green technology adoption. International and regional cooperation helps share experiences and technologies, expand investment in green technology, and promote innovation and environmental responsibility, moving toward sustainable development.

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The Role of Public Sector Organizations in Implementing Low-Carbon Development Strategies in Vietnam

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Abstract

Public sector organizations play an important role in the transition from an unsustainable linear development model focusing on “production, use, and disposal” to an economic model to extend the life of materials and eliminate negative impacts on the environment. The article focuses on the implementation of low-carbon development strategies in public sector organizations in Vietnam. It highlights the challenges faced in implementing the Communist Party of Vietnam's low-carbon development strategies due to limited awareness and capacity among civil servants in public agencies. The article also points out barriers to government green procurement, including limited awareness, capacity to implement legal policies, and structural challenges such as lack of leadership commitment, unclear legal regulations, and the unavailability of green products.

Keywords: *Government green procurement, low carbon economy, implementation of low-carbon development strategies*

1. Introduction

Since the terms "low-carbon development" and "low-carbon economy" were mentioned in the UK Report on "Our Energy Future", many countries have been implementing an economic development model focused on low energy consumption, minimal pollution, and reduced CO2 emissions. Recently, research on the circular economy and low-carbon economy has received much attention from policymakers and scholars. The literature not only focuses on analyzing the benefits of solving environmental and climate change problems but also the benefits of bringing new business opportunities to enterprises. With the promising benefits of promoting a reduction in consumption and reuse or recycling of resources, which are contrary to various aspects of traditional business models, the concept of a low-carbon economy has been increasingly discussed by policymakers and researchers. Recognizing the importance of public sector organizations in the transition to a low-carbon economy, macro-level assessments of the progress and impact of Circular Economy policies are already widely implemented in the European Union. In Asia, “China was one of the first countries to release a specific framework of indicators to track progress as pursued under the ‘Circular Economy Promotion Law’. This development was the start for a series of efforts for developing appropriate indicators to assess Circular Economy policies e.g. the “EU Circular Economy Indicators” or the assessment defined in Action Plan for Circular Economy in Portugal: 2017-2020” (Hinrika Droege, 2021).

The Communist Party of Vietnam identifies low-carbon economic development as one of the transformation methods towards sustainable development. Currently, the literature focuses its attention on analyzing the private sector’s contribution to the low-carbon economy. However, in Vietnam for example, public sector organization account for 29,8% of gross domestic product (GDP) in the expenditure (Institute of Strategy and Financial Policy, 2021). Although Public sector organizations are considered key actors in the transition towards a more low-carbon economy, to date in Vietnam there are few studies on the topic. Based on the gaps identified in the literature, the article analyzes civil servants' awareness of Vietnam's low-carbon development strategies and the implementation of government green public procurement and circular public procurement principles in Vietnamese public sector organizations. The article addresses several key research questions:

1) How are low-carbon development strategies implemented in public organizations in Vietnam?

2) How are government green procurement principles and circular public procurement implemented in public organizations?

3) What difficulties do public organizations encounter in implementing low-carbon economic development strategies?

2. Methods

A data paper is taken from a survey on awareness and capacity to implement low-carbon development strategies in Vietnam. The study population comprised 4800 civil servants in government ministries, departments, and local government agencies. Questionnaires were used to collect information on civil servants' awareness of the low-carbon economy, and implementing low-carbon economic development strategies in public sector organizations.

The assessment of awareness is based on the following basic criteria: knowledge of the characteristics of a low-carbon economy, understanding of Vietnam's low-carbon economic development strategies, and knowledge and beliefs about the opportunities and challenges of implementing the strategies. It also involves awareness of the responsibilities of agencies for transitioning to a low-carbon economy.

In the transition from a linear model to a low-carbon economic model, public sector organizations play an important role. They set the “rule of the game” with important legislative landmarks. In addition, the public sector as a provider of services also generates significant material and energy input/output flows, both direct and indirect (Hinrika Droege. 2021). This article discusses the implementation of low-carbon economic development strategies in public sector organizations. This involves 1) Issuing direction documents by Party committees; 2) Conducting propaganda activities and disseminating information about low-carbon economic development strategies; and 3) Implementing government green procurement principles and circular public procurement through equipment procurement and repair activities.

3. Results

3.1. Issuance of direction documents of Party committees

In recent years, the Vietnamese party, and government has issued documents to implement the goal of developing a low-carbon economy. At the local level, many local Party Committees have directed the Provincial People's Committees to issue Action Plans to respond to climate change; Plans to implement the National Strategy on green growth towards sustainable development for the period 2021 - 2030; Plans to develop a circular economy for the period 2022 - 2025, with a vision to 2030. Some provincial Party Committees have directed Provincial People's Committees, Departments, branches, and People's Committees of districts and cities to issue many Plans, Decisions, and Action Programs to specify tasks on environmental protection and climate change response to local socio-economic conditions.

3.2. Dissemination of information on the circular economy and low-carbon economy

Recently, local authorities have had practical activities to propagate and disseminate the Party's policies and the State's laws on low-carbon economy. Local governments reported that party committees have developed plans and organized sessions to study the Resolution of the 13th National Party Congress, the Party's guidelines and policies, and the state's laws on environmental protection. The low-carbon policies are disseminated to cadres, party members, and the general public by local party committees. Although Party committees at all levels have actively propagated low-carbon development strategies, the awareness of civil servants in the public sector organization is limited. Our 2023 research revealed that most surveyed civil servants have a limited understanding of Vietnam's low-carbon development target.

The data presented in Figure 1 shows that out of a total of 4,800 officials who responded to the questionnaire, 14.3% scored less than 30 out of 100 points. This score is considered equivalent to a very limited level of understanding of the economic development orientation in the Documents of the 13th National Congress of the Party and the regulations on low-carbon economic development in the Law on Environmental Protection.

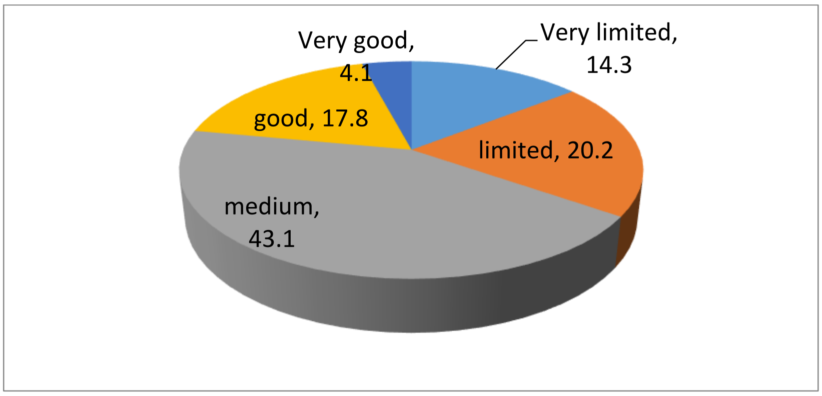

Figure 1: Level of civil servants' understanding of economic development orientation in the 13th National Congress party documents and regulations on developing a low-carbon economy in 2020

Source: Survey on the awareness and organizational capacity to implement low carbon development goals in public organizations in Vietnam

It is evident from the results that a large majority of respondents were not familiar with a low -carbon economy. 39,4% of respondents admitted that this was the first time they had heard of a low-carbon economy. Furthermore, attitudes towards implementation of low-carbon economy were generally positive, with almost all respondents agreeing to the necessity to implement the economic model in Vietnam. 60.9% of respondents acknowledged that a circular economy and a low-carbon economy will contribute to solving environmental issues and addressing climate change. Less than 10% of the respondents believed that developing a low-carbon economy can help improve the capacity and competitiveness of the economy. They also doubted that it could minimize the exploitation of natural resources, maximize the value of resources, reduce social costs in management, environmental protection, and response to climate change, and create incentives for businesses to invest, innovate technology, and reduce production costs.

The respondents did not highly appreciate Vietnam's circular economy and low-carbon economic development prospects.

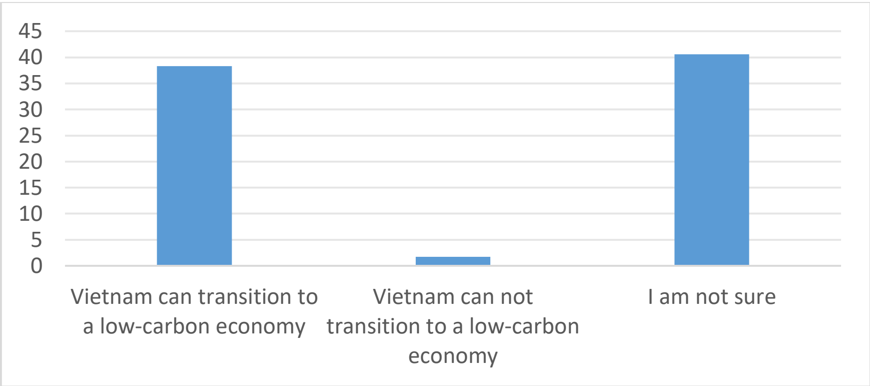

Figure 2: Confidence among civil servants on the potential for transition to a low-carbon economy in Vietnam

Source: Survey on the awareness and organizational capacity to implement low carbon development goals in public organizations in Vietnam

The data presented in Figure 2 shows that over 38% of respondents believe in the prospect of Vietnam's transition to a low-carbon model. More than 40% chose the answer "I am not sure about Vietnam's prospect in transitioning from the current economic model to a circular economy, low-carbon economy," and 1.5% said that Vietnam "cannot transition from the current economic model to a circular economy, low-carbon economy." Concerns about the transition of locals to a low-carbon economy are not uncommon and may stem from a poor understanding of the characteristics and benefits of the low-carbon economy or a lack of information about policies.

3.3. Government green procurement in public sector organizations in Vietnam

For many years, government green procurement has been utilized as an effective governance tool to enhance economic efficiency and promote the transition to a circular, low-carbon economy. In Vietnam, the National Strategy on Green Growth for the period of 2021-2030, with a vision to 2050, specifies that by 2030, at least 35% of total public procurement should be green, and this proportion should increase to 50% by 2050. Current research indicates limited government green procurement in Vietnamese public organizations (Ho, 2017). Moreover, our survey indicates that Vietnamese public sector organizations have not widely implemented government green procurement principles.

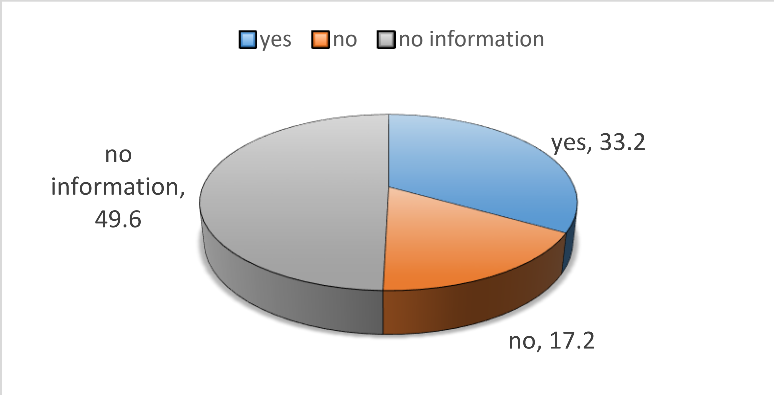

Figure 3: Government green procurement in public sector organizations in Vietnam

Source: Survey on the awareness and organizational capacity to implement low carbon development goals in public organizations in Vietnam

As is evident from the results presented in char 3, more than 40% of respondents didn't know if the government green procurement principle was applied in their agencies. Over 17% said their organization did not apply this procurement principle.

In addition, the majority of respondents reported that their agencies do not use recycled products. Nearly 40% of respondents said they were unsure whether their agencies used recycled products. The study's findings indicate that government green and circular procurement are not widely implemented in Vietnamese public sector organizations. Currently, the Vietnamese Government has not established specific targets for government green procurement for each state agency. The inclusion of government green procurement and circular procurement is not yet a prioritized principle in the bidding process for public equipment procurement. Figure 4 indicates that the obstacles to implementing the principles of government green procurement and circular public procurement stem from both objective factors related to the green product market and subjective factors arising from institutions, policies, capacity awareness of staff, and public organizations leaders.

Government green procurement relies on product availability, awareness, policy implementation capacity of public officials, and clarity in legal rule. “Along the transformation path towards a society characterized by sustainable consumption, finding the balance between limiting unsustainable behaviors and maintaining freedom of choice is a major challenge. Finding this balance requires recognition of the range of behavioral and structural factors, combined with incentives and punitive actions, which are likely to be required”. (David Taylor, 2011). Accordingly, clear rules for public procurement are essential for public institutions to effectively implement policies for the development of a circular economy and low-carbon economy.

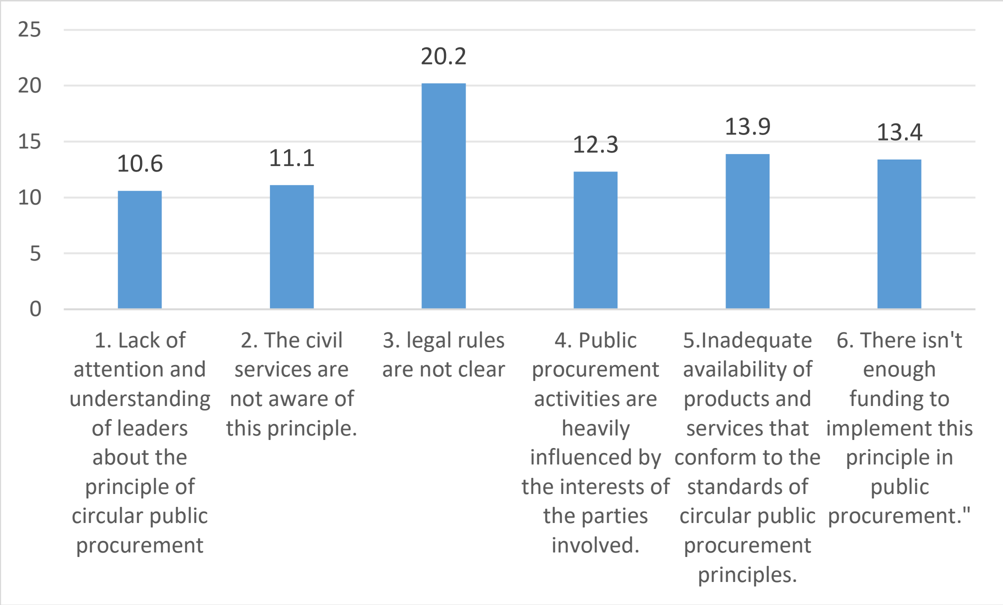

Figure 4: Respondents shared their perspectives on the challenges of government green procurement and circular public procurement in Vietnamese public sector organizations

Source: Survey on the awareness and organizational capacity to implement low carbon development goals in public organizations in Vietnam

4. Conclusion and Implications

The transition to a circular economy and a low-carbon economy is an important solution to help Vietnam adapt to climate change and facilitate the transition to a sustainable growth model. The document from the 13th National Congress of the Communist Party of Vietnam highlights the transition from an unsustainable linear economic model that focuses on production, consumption, and waste to a circular economy and a low-carbon economy. The articles suggest that respondents expressed strong trust in the government's low-carbon policies. Overall respondents were in favour of a transition towards a low-carbon economy while retaining some reservations, notably concerning the development prospects of this model. This may be explained by the lack of information about the policies and benefits of a low-carbon economy.

Besides, the article demonstrates that the implementation of this policy in public organizations in Vietnam is still relatively limited. The lack of information regarding the socio-economic benefits of a low-carbon economy, along with limited awareness of policies, reduces the confidence of civil servants in the prospects of implementing this economic model. This poses a major challenge in successfully implementing the Party's viewpoints and policies, as well as the State's laws on sustainable development. Further research is necessary to evaluate the transition from an unsustainable production-consumption-and-waste model to a new development model with reduced negative environmental impacts in the operations of public sector organizations in Vietnam. Understanding the barriers and enablers of low-carbon economy opportunities is crucial for developing targeted initiatives and stronger policy frameworks.

First, improve the effectiveness of communication regarding Vietnam's development orientation towards the circular economy and low-carbon economy by 2030. Develop clear and easy-to-understand communication content: Communication messages on circular economy and low-carbon economic development policies need to be expressed clearly, easily understood, and accessible. Using simple language and illustrations will help make the content more accessible.

Second, promoting the role of public sector organizations in the transition to a circular economy and low-carbon economy. Although the goals of a transition to a low-carbon economy are ultimately chosen by society, public sector organizations can play a role in bringing about structural change in a stepwise manner. Their transition management provides a basis for coherence and consistency in public policy and can be the spur to sustainable development.

Third, public sector organizations have a clear strategy to collaborate closely with stakeholders to ensure the effective and sustainable implementation of circular economy and low-carbon economic development policies.

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Promote Collaboration among Stakeholders to Develop Net Zero Emission Buildings to Achieve Net Zero Target

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Abstract

With the pressing need to achieve greenhouse gas reduction targets by 2030 and 2050, the development of net-zero emission buildings (NZEBs) has become increasingly crucial. Collaboration among stakeholders plays a key role in achieving this goal. However, this collaboration process still faces many barriers. This study analyzed 37 scientific articles to identify 11 major barriers and proposed some strategies to enhance collaboration, thereby promoting the process of building NZEBs. In particular, the study built a model to illustrate the relationship between these barriers and strategies. The research results provide valuable suggestions for policy makers and decision makers in building effective collaboration strategies.

Keywords: *Net-zero, collaboration, NZEBs*

1. Introduction

The construction industry is one of the largest greenhouse gas emitters, accounting for about one-third of total global emissions (Li et al., 2020). CO2 plays a major role. If no control measures are taken, these emissions will continue to increase and cause serious consequences for the global climate. To cope with this situation, the construction of NZEBs has become an urgent goal. NZEBs not only help reduce emissions but also bring many other benefits such as energy savings and improved air quality. UNEP has called for increased cooperation among stakeholders to promote the development of NZEBs. Although cooperation brings many benefits, this process still faces many barriers. Previous studies have focused mainly on the general barriers to NZEBs' development, but have not yet analyzed specific barriers to collaboration (Lai et al., 2017; UKGBC, 2021).

Currently, there is a lack of in-depth research on the barriers and strategies for building effective collaboration among stakeholders to develop NZEBs. This study aims to fill this gap by synthesizing and analyzing previous studies, thereby identifying key barriers and proposing successful strategies. In particular, the study will develop a model to illustrate the relationship between these factors, providing a scientific basis for the development of policies and strategies to promote NZEBs' development.

2. Methods

This study applied the PRISMA systematic review method to synthesize and analyze the literature related to barriers and strategies in the collaboration to build NZEBs. The PRISMA method helps to ensure the scientific and objective nature of the study, and at the same time provides a comprehensive view of the problem (Yevu et al., 2023).

To collect data for the study, we conducted a comprehensive search on the Scopus database in March 2024. Scopus was selected because it is one of the largest and most highly regarded databases in the scientific field, especially in the fields related to sustainable construction and NZEBs (Cao et al., 2022). We used various keywords to ensure that no important studies were missed. The data search and screening process was carried out according to specific steps as shown in Table 1.

Table 1: Methodological Framework

Stage	Details
Data Acquisition	A total of 341 relevant articles were collected from the Scopus database -> 52 English-language conference papers and journal articles.
Screening	289 articles meeting inclusion and exclusion criteria and 86 articles screened in full text -> 203 articles excluded by title, abstract, and keywords.
Synthesis	37 articles included in the study -> 49 articles excluded for irrelevance.

Source: The author's synthesis

The author established specific criteria for screening and selecting suitable articles for the study. Only peer-reviewed journal and conference proceedings articles written in English and directly related to the research topic were included in the analysis. After searching the Scopus database, the author obtained 341 articles. After eliminating articles that did not meet the criteria, the author carefully read 86 articles to collect data for the study.

With the aim of identifying barriers and successful strategies in partnerships to achieve NZEBs, the author focused on screening articles related to this topic. After evaluating all 86 articles, the author selected 37 most suitable articles for further analysis.

3. Results

3.1. Research objectives on stakeholder collaboration to achieve NZEBs' standards

During the construction and operation of NZEBs, there are many stakeholders involved, from designers, contractors to investors and users. The diversity of these stakeholders creates many challenges in collaboration. This study aims to identify barriers and seek solutions to build an effective collaboration between stakeholders, in order to promote the implementation of NZEBs' projects. The government plays an important role in creating a favorable environment for the development of NZEBs by issuing supportive and encouraging policies (Lu et al., 2020).

3.2. Major challenges in building partnerships towards NZEBs

3.2.1. Lack of engagement among stakeholders

Despite a high level of consensus on the importance of NZEBs and the role of engagement from all stakeholders, collaboration among stakeholders is often difficult in practice. Ineffective stakeholder engagement not only slows down the implementation of NZEBs' projects but also creates conflict and reduces the acceptance of relevant policies (Francis et al., 2022).

Partnership management is a key element in the implementation of NZEBs projects, requiring coordination and influence of stakeholders towards common goals (Bui et al., 2023b). However, managing a diverse network of stakeholders with different needs, values, and expectations is a major challenge. This complexity hinders the building and maintenance of effective collaborative relationships, affecting project progress and success (Vimal et al., 2022; Madhusanka et al., 2022a).

3.2.2. Diversity of stakeholders

While the involvement of multiple stakeholders is considered a key factor in achieving NZEBs (Francis et al., 2022), managing the diversity and complexity of these relationships is a major challenge. Research by Ochoa et al. (2023) has shown that differences in stakeholder roles, goals, and interests can pose significant barriers to building effective collaborative relationships, especially throughout the life cycle of an NZEBs' project (Prieto et al., 2023).

Lack of information about NZEBs is a major barrier to successful collaboration. When information is lacking, suspicion and distrust will increase, making it difficult to convince stakeholders to participate in the NZEBs' development process (Pan and Pan, 2020a). Furthermore, lack of information can be exploited to create misunderstandings and cause unnecessary risks (Duan et al., 2024). To overcome this problem, providing complete and accurate information to all stakeholders, especially asset users, is extremely important (Wilson and Rezgui, 2013).

Leadership plays an important role in promoting cooperation among stakeholders to achieve NZEBs. Ineffective leadership can undermine motivation, create conflict, and hinder project implementation. In particular, the inability to effectively coordinate stakeholders with different interests and roles throughout the project life cycle is a major challenge (Falana et al., 2024).

3.2.3. Conflicting interests and ineffective communication

NZEBs are ecosystems that include multiple stakeholders, each with distinct interests that may change over the course of the project. The diversity and complexity of these interests makes it difficult to identify and resolve conflicts (Chinyio and Vogwell, 2007; Sheng et al., 2020). For example, producers are interested in the market, developers are interested in market value, and users are interested in cost (Addy et al., 2022). These competing interests, along with other uncertainties, create many challenges for collaboratively building NZEBs. Studies (Prieto et al., 2023; Li et al., 2019) have shown that poor communication is a major barrier to collaboration in NZEBs' projects. Ineffective communication between professionals such as architects, managers, and designers can lead to misunderstandings, conflicts, and hinder the implementation of NZEBs. This highlights the importance of building an effective communication system to ensure the success of NZEBs' projects. Conflicts between stakeholders in the NZEBs' development process often arise from differences in interests, goals, and values (Brunet and Aubry, 2016). These conflicts can have many negative consequences, from weakening the partnership to delaying the project and increasing costs (Bui et al., 2023b). This shows that conflict resolution is an important factor in ensuring the success of NZEBs' projects.

Lack of trust among stakeholders is a major barrier to collaboration in NZEBs' development (Vimal et al., 2022). The main cause of this problem is the lack of effective information sharing and the use of various communication tools (Mavrigiannaki et al., 2021). This leads to a lack of transparency and weakens the relationship between stakeholders.

3.2.4. Roles and responsibilities of stakeholders

The diversity of roles and responsibilities of stakeholders in the NZEBs' development process requires clear definition to ensure effective collaboration. This lack of clarity can create many obstacles, slow down progress, and affect the relationship between stakeholders (Duan et al., 2024). In particular, the limited experience of some construction industries in the NZEBs' field further complicates this issue (Mavrigiannaki et al., 2021).

The shift to green construction to reduce carbon emissions has led to changes in stakeholder attitudes (Pan and Pan, 2020a). Reluctance to change behaviour and negative attitudes towards NZEBs can undermine stakeholder collaboration (Bui et al., 2023a). This suggests that stakeholder attitudes play an important role in facilitating or hindering the transition to NZEBs.

3.3. Key factors to ensure effective collaboration among partners to achieve NZEB goals

Successful strategies for stakeholder partnership in building NZEBs are methods, techniques and actions that promote effective collaboration, resolve conflicts and ensure project success. In other words, these are tools that help stakeholders work together harmoniously to achieve common goals (Eyiah-Botwe et al., 2016). Ineffective collaboration among stakeholders can pose many risks and hinder the implementation of NZEBs (Mavrigiannaki et al., 2021).

Although Vimal et al. (2022) have emphasized the importance of proactively applying successful strategies to promote collaboration among stakeholders in building NZEBs, there is currently a lack of comprehensive research on specific strategies and the role of each stakeholder in implementing these strategies. This suggests that more research is needed to better identify effective strategies and how to apply them in practice. Through an analysis of 37 articles, this study identified some key success strategies and key stakeholders that could implement these strategies to address barriers to NZEBs' collaboration (Figure 1). This is the first study to establish a clear link between strategies and stakeholders, and highlights the importance of engaging stakeholders such as government, project managers, construction professionals, researchers, and media partners to jointly identify and implement these strategies. The study classified stakeholders in NZEBs' projects into four main groups: demand, supply, regulatory, and institutional (Ozorhon, 2013). Based on the study results, three key stakeholder groups were identified to implement success strategies: regulators, construction practitioners, and researchers (Figure 1). Regulatory agencies play a key role in policy formulation and facilitating the implementation of NZEBs.

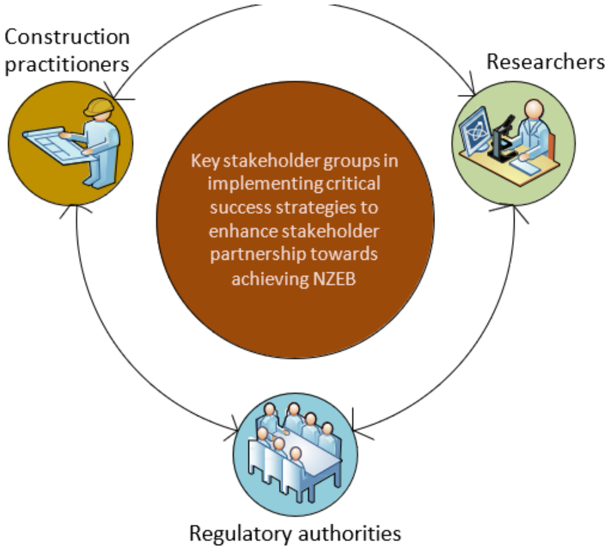

Figure 1: Key stakeholders in implementing NZEB strategies

Source: Pan and Pan, 2020b

Construction practitioners are those directly involved in the construction process and may include architects, engineers, contractors, etc. Researchers play a role in providing knowledge and support for the implementation of NZEBs. These groups need to work closely together to achieve success. Effective stakeholder engagement is not simply about inviting stakeholders to participate, but about working together to achieve a common goal. Research shows that active stakeholder engagement is a key factor in ensuring the success of NZEBs' projects, helping to reduce conflicts and enhance collaboration (Xia et al., 2018). To achieve this, all stakeholders, from governments to construction professionals and researchers, need to be clear about their roles and work together. Researchers are focusing on developing frameworks and strategies to enhance stakeholder engagement (Liu et al., 2019). One of the first steps is to clearly define the roles of each stakeholder (Bartlett and Howard, 2000).

Developing an NZEB requires the involvement of various stakeholders, each of whom plays an important role (Pan, 2013). The absence of any stakeholder can negatively impact the collaboration process and slow down the project progress. Therefore, clearly identifying stakeholders and their roles is crucial to building effective collaboration (Falana et al., 2024). To achieve this, construction project managers can take a proactive role in identifying stakeholders at each stage of the project. In addition, organizing workshops and meetings is also an effective way to identify and explore potential stakeholders (Metta et al., 2020).

Effective communication is essential to ensure the success of NZEBs' projects. Regular communication between stakeholders helps to enhance mutual understanding, promote cooperation, and effectively resolve problems that arise (Bui et al., 2023a). To achieve this, transparent and timely information sharing on project objectives, policies, and progress is required. At the same time, building an open communication environment and respecting differences is also important (Pan and Pan, 2020b).

Research shows that providing adequate information about NZEBs is an important factor in enhancing collaboration among stakeholders and promoting NZEB implementation (Pan and Pan, 2020a). Raising awareness about NZEBs helps reduce risks, increase trust, and facilitate collaboration. To achieve this, there is a need for coordination between regulatory agencies, construction professionals, and researchers in providing information, organizing training activities, and sharing experiences.

Identifying and balancing the interests of stakeholders is an important factor in building effective collaboration in NZEBs' projects. To resolve issues and build sustainable partnerships, project managers need to work closely with stakeholders to identify and balance different interests. Researchers can contribute to this by organizing workshops and seminars to gain a deeper understanding of stakeholder interests and how to build sustainable partnerships (Prieto et al., 2023).

Effective conflict management is an important factor in building sustainable collaborative relationships in NZEBs' projects (Vimal et al., 2022). Timely and effective resolution of conflicts helps to minimize misunderstandings and disputes, thereby facilitating collaboration. To achieve this, project managers and stakeholders need to be equipped with knowledge and skills in conflict management (Mavrigiannaki et al., 2021). At the same time, researchers need to focus on studying the causes of conflicts in NZEBs' projects and finding effective solutions (Kane and Boulle, 2018).

Clearly defining the roles and responsibilities of each stakeholder is a core factor in building effective collaborative relationships in NZEBs' projects. When stakeholders clearly understand their roles, they are more likely to collaborate and contribute to the overall success of the project. However, research shows that there are still some knowledge gaps, especially for end users (Falana et al., 2024). Therefore, efforts are needed from project managers, the research community, and relevant organizations to clearly define the roles of each stakeholder and enhance their understanding of these roles.

Positive attitudes of stakeholders are a core factor to ensure the success of NZEBs' projects. To build effective collaborative relationships, it is necessary to clearly identify the attitudes of each stakeholder and have appropriate solutions to change negative attitudes. These solutions may include information provision, training, incentives, and communication activities. Research shows that identifying and controlling stakeholders helps to develop appropriate strategies to change attitudes (Liu et al., 2019).

Open communication, transparency, and trust are essential to building effective partnerships in NZEBs' projects. When stakeholders have a clear understanding of their roles, responsibilities, and common goals, they will trust and be willing to cooperate with each other. Lack of information and transparency can cause suspicion and distrust among stakeholders, negatively affecting project implementation (Yu and Ahlgren, 2023). Therefore, stakeholders, especially suppliers and governments, need to enhance communication, build trust, and create a transparent working environment to achieve sustainable partnerships.

Effective leadership management is a core factor to ensure the success of NZEBs' projects. Good leadership will help set common goals, motivate and inspire stakeholders, and build sustainable partnerships. To achieve this, project managers need to be equipped with the necessary leadership skills and have support from the government and relevant organizations. Building and maintaining effective collaborative relationships requires managers to be able to establish common rules, facilitate dialogue, build trust, and seek common interests (Zou and Alam, 2020; Kotter, 2008; Vangen and Huxham, 2003; Liu et al., 2022; Sumiyati and Purisari, 2020; Rita et al., 2023).

To promote collaboration among stakeholders in NZEBs' development, policymakers need to develop effective incentive mechanisms and policies. Research shows that economic and social incentives play an important role in promoting this cooperation (Gardner and Stern, 2008; Duan et al., 2024; Wang et al., 2021). Governments need to design appropriate incentive policies to encourage stakeholders to participate in the NZEBs' development process (Graham et al., 2022).

3.4. Fuzzy cognitive model designed to address the challenges in NZEB partnership

Stakeholder theory provides a solid theoretical foundation for this study. According to Freeman (1984, 1999), an organization is a network of cooperative relationships among stakeholders. The study developed a fuzzy cognitive model to identify successful strategies and barriers in building partnerships among stakeholders to achieve NZEBs. The model shows the causal relationships between these factors and contributes to the construction of a more comprehensive theoretical framework on partnerships in the field of NZEBs.

This study uses Fuzzy Cognitive Map (FCM) to build the conceptual model. FCM, introduced by Kosko (1986) based on the work of Axelrod (1976), is a powerful tool for visualizing and analyzing complex relationships between elements in a system. FCM has been widely applied in many fields, including management, decision making, and construction (Gan et al., 2023; Olazabal & Reckien, 2015;

Mpelogianni & Grouppos, 2018). In this study, FCM helps us explore the causal relationships between successful strategies and barriers in building partnerships to achieve NZEBs.

Clearly identifying stakeholders, providing adequate information, and applying successful strategies are important factors to promote collaboration in the process of building NZEBs. The fuzzy cognitive conceptual model, built on 37 research articles, provides a comprehensive view of the complex relationships between these factors. The model shows that successful strategies not only directly impact on overcoming barriers but also have a reciprocal relationship with each other. This suggests that to achieve success, a harmonious combination of different strategies is needed.

4. Conclusion

Partnerships among stakeholders in achieving NZEBs are a pressing issue globally. Despite many efforts, building and maintaining effective partnerships remains a challenge. Research on barriers and successful strategies for such partnerships is limited. Therefore, identifying barriers and finding effective solutions is essential to promote the transition to NZEBs. Through a systematic review of 37 studies, we identified some key barriers that affect stakeholder collaboration in the implementation of NZEBs. In particular, ineffective participation, lack of information and knowledge, and competing interests were identified as the most significant barriers. In addition, the study also proposed some specific strategies to overcome these limitations, and emphasized the importance of building and maintaining close partnerships among stakeholders to achieve NZEBs' goals.

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Achieving Net Zero: The Role of Vietnam's Oil and Gas Industry in Sustainable Energy Transition

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Abstract

By 2050, Vietnam commits to achieving net-zero emissions, and transitioning its oil and gas industry toward clean energy solutions is essential for addressing climate change and promoting sustainable economic growth. The study uses an in-depth review of existing research and government policies to assess Vietnam's efforts toward achieving net-zero emissions by 2050. The results reveal that the sector faces challenges such as heavy dependence on fossil fuels and the need for substantial financial investment and technological advancements to transition to renewable energy. However, there are significant opportunities for Vietnam to develop offshore wind energy and form international partnerships for financial and technological support. By prioritizing cost-effective strategies such as improving energy efficiency, electrifying operations, implementing CCUS, investing in renewable energy, and using digital technologies, the industry can make significant progress toward sustainability. Collaboration between governments, industry and technology providers is essential to support these initiatives through policy, investment and innovation. The transition to Net Zero is not only a moral imperative, but also an opportunity to drive operational excellence and secure a competitive advantage in the evolving energy landscape.

Keywords: *Net-zero emissions, energy transition, renewable energy, emissions reduction, clean technologies, sustainable development, oil and gas industry*

1. Introduction

In the energy transition trend, all economies must shift to green development, circular economy, and low carbon. The world oil and gas industry is also reshaping its development strategy according to the trend of energy transition, reducing emissions, developing renewable energy, and restructuring operations to lower carbon fields. Vietnam has committed to achieving the Net Zero target by 2050, as declared at the COP26 Conference in 2021. This commitment represents the country's efforts to mitigate climate change and transition to a more sustainable economy and low carbon emissions. The Vietnamese government has issued the National Strategy on Climate Change to 2050, and Deputy Prime Minister Le Van Thanh officially approved this document on July 26.

In that context, the oil and gas industry – one of the major contributors to greenhouse gas emissions – plays a key role in adjusting its operations to global environmental goals. Currently, Vietnam is facing major challenges in reducing dependence on fossil fuels, promoting renewable energy, and increasing energy efficiency. At the same time, businesses in the oil and gas industry must adjust production and business strategies to achieve environmental criteria while still ensuring national energy security. In addition, changes in international policies and sustainable investment trends also push companies to innovate and seek cleaner technologies and processes.

2. Literature review

Researching Vietnam's actions towards Net Zero 2050 in the oil and gas industry, there have been many perspectives given by both domestic and foreign authors. Research by Nguyen Huu Luong and colleagues (2024) shows that the energy industry is facing challenges from the energy transition trend to reduce carbon emissions from activities, aiming to achieve emissions net zero emission by 2050. A study and diagnosis of Net Zero scenarios for Vietnam's energy sector by Vietstar and Energy Modeling

Lab (EML) (2023) using energy models to diagnose predict and evaluate scenarios towards Net Zero for the energy sector, including the oil and gas industry to support sustainable energy transition. The study shows feasible scenarios for optimal investment technology transformation and focuses on cooperation between domestic and foreign resources. However, reliance on international support and the feasibility of applying new technologies face many challenges. In addition, authors from Vietnam Energy Magazine (2023) also analyzed the Government's energy development policies and plans with a focus on the oil and gas industry and high-emission industries. This research highlights financial and technological barriers, major challenges that Vietnam is still unable to handle. In addition, according to research by Bui Hong Diem and colleagues (2022), thanks to the synchronous implementation of pollution treatment and control solutions, offshore oil and gas search, exploration and exploitation activities in Vietnam Nam does not have a significant impact on the water environment, sediment environment, benthic community and air environment. Vietnam is also ready to open an era of renewable energy growth to meet its energy security and climate commitments. These developments and strategic commitments will gradually shape Vietnam's energy transition roadmap over the next decade (Nguyen Xuan Phuong et al., 2022)

Research by Johnsen et al. (2021) analyzing emissions reduction initiatives in Norwegian oil fields shows that using carbon capture and storage (CCS) technology can reduce emissions by up to 30%, however, high initial investment costs are a challenge for this initiative. The study highlights the importance of cooperation between the government and the oil and gas industry to achieve success in each project. In Smith & Zhang's (2020) study on the impact of digitalization on emissions reduction in North American oil companies, the authors did a quantitative analysis using emission data. emissions from major oil and gas companies in North America, and a direct correlation between digitizing operations and reducing emissions was found. Specifically, automated drilling and production will be able to cut emissions by up to 15%. Ahmed and Watson (2019) perform a comparative analysis of renewable energy integration in oil exploration in Middle Eastern countries to find challenges and opportunities. The study concluded that countries that integrated solar energy into the oil extraction process reduced emissions by 20 to 25%. However, research also points to economic and political challenges that have slowed adoption. In Da Nang city, research by Naoki Mori and colleagues (2023) has identified that Da Nang faces major challenges in meeting growing energy demand and decarbonizing the energy system. quantity of the city. Currently, Da Nang must depend on power sources from neighboring provinces such as Quang Nam (for hydropower) and Quang Tri (for coal power), because there are no large-scale power plants. Vietnam Electricity Group (EVN) manages the distribution and retail of electricity nationwide, including cities like Da Nang. Therefore, Da Nang currently has limited control over the type of power it consumes. However, Da Nang can increase its ability to self-supply electricity by developing solar energy because the city already has significant solar power potential, and can contribute to Da Nang's electricity supply from renewable energy. Creative and environmentally friendly.

Based on previous studies, it is possible to identify some research gaps in Vietnam's journey towards Net Zero 2050 in the oil and gas industry. Despite many policies and plans having been proposed, there is still a lack of detailed research on the feasibility and effectiveness of these policies at each specific stage of development. For example, data on the practical implementation of these policies in key phases of the energy transition needs to be included. Furthermore, carbon capture, utilization and storage (CCS/CCUS) technology is considered an important solution to reduce emissions, but its widespread application in the oil and gas industry has not yet been researched and evaluated. Existing studies often lack detailed evaluations of how these policies will function in practice and whether they can deliver the intended outcomes at different phases of implementation. This gap makes it difficult to gauge the overall success of these strategies in driving the energy transition. Key questions about the cost of implementing this technology, its scalability, and its broader socio-economic impact remain unanswered. For example, according to a Global CCS Institute report, large-scale CCS projects can cost between $500 million to over $1 billion, raising concerns about financial viability in developing countries like Vietnam. Furthermore, the absence of detailed socio-economic assessments means that the potential effects on local communities and industries are not well understood. Another area that lacks comprehensive research is the impact of the energy transition on the workforce within the oil and gas industry. Current studies provide little insight into how this shift, especially towards renewable energy and hydrogen, will affect workers. There is limited analysis of the need for workforce restructuring and new training programs as the industry moves away from traditional fossil fuels. For instance, as the sector transitions to renewable energy, the demand for new skills will rise, yet few studies examine the scale of retraining required or the socio-economic effects on employees. According to the International Labour Organization (ILO), the energy transition could create millions of jobs globally, but it could also result in job losses in traditional sectors if workers are not adequately retrained. In Vietnam, this knowledge gap poses a challenge to effectively preparing the workforce for new opportunities in clean energy. Understanding these dynamics is essential to ensure a just transition for workers and to sustain employment levels as Vietnam advances towards its Net Zero 2050 goals. The authors believe that this is a research gap that needs to be overcome.

In light of these research gaps, the authors suggest that future studies should focus on a detailed evaluation of Vietnam’s strategies to reduce emissions, with particular attention to the feasibility and effectiveness of policies at each stage of development. Furthermore, a thorough investigation of CCS/CCUS technology and its socio-economic impacts is essential. Equally important is the need to analyze the effects of the energy transition on the workforce, particularly in relation to training and restructuring as the industry pivots toward renewable energy and hydrogen. These insights are crucial for Vietnam’s successful transition to a low-carbon future.

3. Methods

This study uses two research methodologies: literature review, secondary data analysis, and targeted knowledge synthesis. A critical review of Vietnam's climate change policy that synthesizes information from practitioner and academic literature forms the core of the study. The information sources are the media, government data, think tanks, policy units, and the academic community. To cover the most recent discussions on the green transition, we also gathered the viewpoints of Vietnamese academics and CSO leaders via social media and direct communication. We use interdisciplinary views from the fields of climate science, economics, politics, history, geography, psychology, and sociology to clarify the gaps in the policies that are in place, emphasize the urgency of taking comprehensive action on climate change, and reconsider the roles that civil society and the developmental state should play.

After synthesizing and analyzing many publicly available research sources and documents, the research based on that basis comprehensively evaluates Vietnam's efforts in the journey towards the Net Zero goal. by 2050. The authors searched for research, reports, and dissertations related to activities toward the goal of reducing greenhouse gas emissions on reputable scientific databases such as Scopus, Web of Science, Statista, and Google Scholar. In addition, the group also researched legal documents, strategies, and policies of the Vietnamese Government related to climate change and the net zero emissions target to clarify the legal framework and directions. national strategy. To further study Vietnam's challenges and opportunities, the authors also searched for reports from the World Bank, the United Nations Environment Program UNEP, and the Intergovernmental Panel on Climate Change. IPCC to get a global view on emissions and compare Vietnam's strategy with other countries. Finally, based on those scientific databases, collected statistics on greenhouse gas emissions and related industries are also analyzed to assess the current situation as well as recommendations moving forward. The future net emissions will be "zero" in Vietnam, especially in the oil and gas industry. By combining information from multiple sources and using a variety of approaches, the research team built a comprehensive picture of Vietnam's efforts towards Net Zero, evaluating achievements achieved, and remaining challenges, and providing practical recommendations for the future.

4. Results

4.1. Current situation of the oil and gas industry in Vietnam

Over the past decades, Vietnam has witnessed a steady increase in greenhouse gases. Greenhouse gas emissions are predicted to continue to increase in the coming years (Table 1).

Table 1: Projected emissions achieved in 2030 and 2050 across sectors

No.	Sector	Reduction by 2030 (%)	2030 Limit (million $mtCO_2e$)	Reduction by 2050 (%)	2050 Limit (million $mtCO_2e$)
1	Energy	32.6	457	91.6	101
2	Agriculture	43.0	64	63.1	56
3	Forestry & Land Use	70.0	-95	90.0	-185
4	Waste	60.7	18	90.7	8
5	Industrial Processes	38.3	86	84.8	20

Source: Authors' synthesis

In the APEC region - Asia-Pacific Economic Forum, Vietnam has the highest growth rate in coal consumption compared to the other 5 countries. In particular, the period 2010 - 2020 witnessed a huge growth in consumption with an average growth rate of 12.9%/year (EGEDA, 2021). According to the 2020 Vietnam Energy Statistics Report, the use of coal as an input fuel for coal-fired power plants accounts for 63% of the total amount of coal consumed in the electricity industry, with the remaining 35% being used in power plants. iron and steel industry, cement, mining, research production or chemicals. Since 2015, Vietnam has gradually transformed from a coal exporting country to a net coal importing country. Specifically, imported coal output reached a record level in 2020 with 54.8 million tons, larger than the total domestic coal output of 11.5 million tons. At the same time, with a commitment to achieve carbon neutrality by 2050, Vietnam Electricity Group decided to stop developing new coal power projects and reduce dependence on this energy source. In the heavy industry sector, the proportion of coal consumed will also gradually decrease in the coming decades, but at a slower rate of decline than in the power generation sector.

Table 2: Coal consumption of Vietnam from 2015 to 2019 (1,000 tons)

Items	2015	2016	2017	2018	2019
Production	39,888	37,711	37,227	41,387	45,671
Exports	1,748	1,243	2,229	2,387	1,143
Imports	6,927	13,199	14,677	22,749	43,786
Total domestic consumption	**43,711**	**48,941**	**49,576**	**68,256**	**85,443**

Source: Vietnam Energy Statistic 2020

Coal production has increased gradually over the years and has a proportional relationship with the rate of domestic consumption. Specifically, in 2018 and 2019, when coal output only increased slightly but domestic consumption increased dramatically, leading to the forced import of coal to meet consumption demand. That is the reason coal imports tend to increase over the years. Domestic coal production has tended to increase over the years, but there is a negative correlation with the amount of coal export gradually decreasing. This may reflect the policy of prioritizing coal retention for domestic consumption to ensure domestic coal supply to meet growing demand. Dependence on imported coal is likely to continue in the future, if domestic energy and production policies are not adjusted promptly.

Both overall coal consumption and industrial coal consumption tend to increase steadily over the years, showing that industry contributes largely to coal consumption, especially when industrial energy demand increases high to serve production. In 2018 to 2019, coal consumption increased significantly due to the expansion of industrial projects, coal power plants and heavy manufacturing industries such as steel and cement. Growth in industrial coal consumption is likely to come from the implementation of large infrastructure projects and increased energy demand for large manufacturing industries. With industrial coal consumption accounting for a large proportion of total consumption, this trend will also continue in the coming years, especially as Vietnam continues to increase its industrial and infrastructure projects. However, this increase can cause environmental challenges, especially carbon emissions and air pollution. This could also promote the search for alternative energy sources or increase the efficiency of coal use in industry.

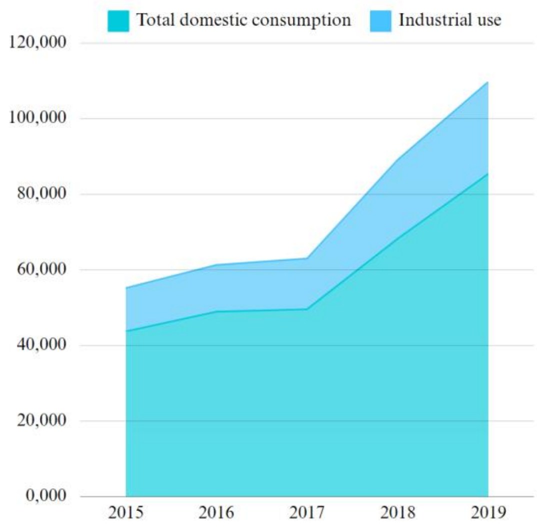

Figure 1: Coal used in industry out of total coal consumed from 2015 - 2019 (1,000 tons)

Source: Vietnam Energy Statistic 2020

According to Fuel Price Projections for Vietnam 2021, natural gas plays an important role as one of the alternative fuels in the energy transition process, thanks to being more environmentally friendly than other fuels, and at the same time, natural gas is also an option. suitable for businesses when the infrastructure, technology and financial mechanisms for renewable energy are fully formed. In addition, natural gas is also a supplementary fuel source in the long term. However, a complete 100% transition to renewable energy is unlikely to happen in the near future, but the combined combustion of natural gas and hydrogen could be one of the clean, green and immediate steps forward. The most economical for the electricity industry to date.

Table 3: Natural gas used of Vietnam from 2015 to 2019 (1,000 tons)

Items	2015	2016	2017	2018	2019
Domestic exploitation	9,137	10,390	9,580	9,700	9,960
Power Generation use	7,480	8,481	7,569	7,519	7,852
Gas processing plants	360	382	404	517	469

Source: Vietnam Energy Statistic 2020

The amount of natural gas exploitation has fluctuated slightly over the years, in general there has been a slight upward trend, showing that the exploitation capacity is gradually stabilizing. Furthermore, natural gas used in electricity production tends to increase slightly, showing that the demand for gas for electricity generation remains stable. The rapid growth in gas flows to processing plants reflects the expansion of these plants to increase gas processing and handling capacity. Long-term vision can see that the demand for natural gas for power generation and gas processing will continue to increase, especially as Vietnam promotes the development of clean energy sources and production and supply requirements. Stable electricity. However, the ability to exploit domestic gas may be limited, leading to the need to search for suitable imported sources or develop alternative energy.

In 2023, according to Vietnam Oil and Gas Group (PVN), Vietnam's crude oil reserves are expected to increase by 16.97 million tons, oil exploitation output will reach 10.84 million tons, exceeding 24% of the plan. annual plan (Kushchenko et al., 2023). In addition, in the same year, Vietnam exported 2.7 million tons of crude oil and imported 10.2 million tons to supply the two largest oil refineries in Vietnam, Nghi Son and Dung Quat. Kuwait is Vietnam's main crude oil supplier, accounting for nearly 90% of total output. Despite significant oil production, Vietnam still lacks expertise in oil refining technology.

Table 4: Crude oil used of Vietnam from 2015 to 2019 (1,000 tons)

Items	2015	2016	2017	2018	2019
Domestic exploitation	16,880	15,100	13,500	11,860	10,980
Imports	182	436	636	5,396	7,918
Exports	9,181	8,100	7,390	4,610	3,723
To oil refineries	6,748	7,355	6,591	12,077	15,505

Source: Vietnam Energy Statistic 2020

Domestic crude oil production tends to decrease continuously, showing a decline in resources or a weakening of domestic exploitation capabilities. In contrast, crude oil imports increased sharply, reflecting increasing dependence on imports to meet domestic demand. The amount of export over the years has decreased sharply because of the priority given to providing these resources to the domestic market. In addition, the expansion of the capacity of oil refineries or the need to refine crude oil to serve domestic production is also increasing, reflected in a sharp increase in the amount of oil supplied to refineries. Vietnam will likely continue to increase crude oil imports to meet domestic demand due to the decline in domestic exploitation output. This trend is likely to result in reduced crude oil exports and increased use by refineries to meet domestic demand and produce refined oil products.

Although fossil energy plays an important role in Vietnam's electricity supply today, the transition to renewable energy sources is influenced by factors. The use of fossil fuels leads to CO2 emissions that contribute to climate change and pollution. Therefore, fossil energy sources (coal, gas, oil) are gradually losing priority in the government's electricity supply program due to the increasing development of renewable energy sources in Vietnam. Investment in research and technology development in the renewable energy industry is creating opportunities for Vietnam to establish a clean and sustainable electricity supply in the future.

4.2. Comparison with other countries

China leads in energy production but still represents a smaller fraction of the global total, indicating widespread global production. Vietnam and Malaysia have the lowest production, which is typical for smaller economies. The USA and China are the largest contributors to global CO2 emissions, reflecting their industrial activity. Vietnam, despite lower production, has significant emissions, potentially due to inefficient energy use or reliance on non-renewable sources. The USA and China dominate electricity consumption due to their industrial bases. India consumes a large amount of electricity, likely relying on imports to meet its needs. Vietnam leads in renewable energy use among the listed countries, showing a strong focus on sustainable energy. The USA and China have lower percentages, relying more on fossil fuels, suggesting a potential area for policy improvement. Economic powerhouses such as China and the United States not only lead in energy production and consumption but are also major sources of CO2 emissions.

Table 5: Comparison between Vietnam and other countries

Country	World	China	Japan	USA	India	Malaysia	Korea	Thailand	Vietnam
Production (MTOE)	14745	2719	507	2364	638	86	163	70	58
Total CO_2 Emission ($MtCO_2$)	33622	9919	1024	4893	2310	237	577	261	264
Electricity Consumption (TWh)	22848	6568	928	4498	1591	159	559	193	209
Renewable Energy (% of TPES)	10.96	12.18	8.55	4.04	2.17	2.24	2.79	5.7	16.42

Source: Vietnam Energy Statistic 2020

Vietnam, despite its smaller size, is making significant progress in adopting renewable energy, which shows its potential and commitment to reducing dependence on fossil energy and developing sustainably. The need to increase energy efficiency and transition to renewable energy is urgent to cope with global climate change. One of the solutions considered to be the solution to climate change and sustainable development is energy transition. Specifically, the energy transition trend is happening quickly and strongly. Major oil and gas companies around the world are also shifting investment to renewable energy to fulfill commitments for a low-carbon or "lower-carbon" future (Dao Minh Phuong et al., 2021). The energy industry in general and the oil and gas industry in particular are facing an energy transition trend to reduce carbon emissions from activities, aiming to achieve net-zero emissions by 2050 with main trends including: (1) Energy saving, (2) Renewable energy development, (3) Electrification, (4) CCS/CCUS and (5) Hydrogen development. (Nguyen Huu Luong, 2024).

4.3. Challenges and opportunities

4.3.1. Challenges

Vietnam's oil and gas industry, especially projects related to natural gas and oil, still accounts for a large proportion of the national energy structure. The transition from oil and gas to renewable energy requires large investment costs and a long time. Additionally, clean energy projects, especially offshore wind and emissions reduction technologies, require significant infrastructure and capital. Oil and gas enterprises like Petrovietnam need to mobilize more finance and improve technological capacity to transform. As other countries are stepping up emissions reduction efforts, Vietnam needs to compete in attracting investment in renewable energy projects, while maintaining sustainable economic development.

4.3.2. Opportunities

The oil and gas industry can take advantage of existing infrastructure to develop offshore wind energy projects, especially along Vietnam's long coastline. Companies have started implementing these projects, which not only help reduce emissions but also open up new revenue streams. Improving energy efficiency in operations is one way to reduce emissions. This includes upgrading equipment to more energy-efficient models, optimising processes to reduce waste and implementing energy management systems. For example, the use of electric submersible pumps powered by renewable energy can significantly reduce the carbon intensity of manufacturing operations. These measures not only reduce emissions but also lower operating costs over time, making them a cost-effective choice.

Upstream electrification, where feasible, can lead to significant emissions reductions. This involves replacing diesel-powered machinery and equipment with electric alternatives that can be powered by renewable energy sources such as wind or solar. Norway's offshore platforms, which use hydroelectricity to power their operations, are a prime example of this strategy in action. Electrification helps to significantly reduce direct emissions from burning fossil fuels on site. Furthermore, by capturing CO2 emissions at source and either reusing them in other industrial processes or storing them underground, CCUS (Carbon Capture, Utilization, and Storage) technologies play a key role in achieving net-zero emissions. While the initial investment and operating costs of CCUS can be high, technological advances and economies of scale are expected to reduce costs. In addition, incentives for carbon capture and storage, such as carbon pricing or tax credits, could improve the economics of CCUS implementation.

Vietnam can cooperate with international partners to access advanced technology and funding for clean energy projects. This helps strengthen the capacity to manage and implement large projects related to renewable energy. Vietnam's commitment to achieving Net Zero can attract interest from green investment funds, which will promote the development of clean energy projects, improving Vietnam's position on the energy map global sustainability. Therefore, investing in renewable energy sources to power upstream operations is an effective way to reduce carbon emissions. The oil and gas industry can either invest directly in renewable energy projects, such as solar or wind farms, or purchase Renewable Energy Certificates (RECs) to offset emissions. This not only helps achieve net zero targets, but also diversifies energy sources and reduces dependence on fossil fuels.

In addition, investing in digital technologies, including artificial intelligence (AI) and big data analytics, can optimise upstream operations, improve energy efficiency and reduce emissions. For example, AI can optimise drilling and production processes, reducing energy requirements and minimising emissions. Digital twins, virtual replicas of physical assets, can simulate and analyse operations to identify ways to cost-effectively reduce emissions.

5. Conclusion

In the context of the global energy transition, economies are striving towards green development, circular economies, and low-carbon growth. The oil and gas industry, a major contributor to greenhouse gas emissions, is being reshaped to align with global environmental goals. This study was conducted to explore Vietnam's actions toward achieving net-zero emissions by 2050, with a particular focus on the oil and gas sector. The urgency of this research stems from Vietnam’s commitment to the COP26 targets, where the country pledged to significantly reduce carbon emissions and transition to a low-carbon economy.

The research highlights both the challenges and opportunities faced by Vietnam's oil and gas industry. On the one hand, the sector remains highly dependent on fossil fuels, and transitioning to renewable energy requires substantial financial investment, technological advancements, and time. On the other hand, Vietnam has significant opportunities to leverage its existing infrastructure for offshore wind energy projects and to forge international partnerships for financial and technological support. These efforts could help position Vietnam as a leader in sustainable energy in the region.

However, limitations exist in this research as it does not fully account for developments in recent years, particularly new technologies and policies introduced after 2020. Future studies should further evaluate how these emerging factors impact the feasibility and timeline for Vietnam to achieve its net-zero target. Nevertheless, this research lays the groundwork for understanding the strategic direction and the pivotal role of the oil and gas industry in Vietnam’s energy transition.

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Developing Renewable Energy Towards a Low-carbon Economy and Practice in Vietnam

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Abstract

Climate change is increasingly proven to be caused by human activities. The root cause of global climate change is the burning of fossil fuels such as coal, oil and natural gas, leading to CO_2 emissions and increasing greenhouse gas concentrations in the atmosphere. The world uses a huge amount of fossil fuels for lighting, heating, driving, and carrying out economic activities and serving growth. To address the challenges of climate change mitigation as well as sustainable supply and use of energy resources, a transition to a low-carbon economy through renewable energy development is necessary. Therefore, countries including Vietnam have made strong commitments to reduce global greenhouse gas emissions and protect the Earth. The article focuses on clarifying the connotation of low-carbon economy, renewable energy, and renewable energy development towards a low-carbon economy that has become an inevitable path for all countries in the world, including Vietnam. At the same time, the article focuses on analyzing policies, strategies, advantages and challenges in developing renewable energy in Vietnam until 2050.

Keywords: *Energy transition, renewable energy, low-carbon economy, sustainable development, climate change*

1. Introduction

Currently, climate change is becoming increasingly serious, causing great impacts on human living environment. Rising global temperatures in the first two decades of the 21st century are the leading cause of global climate change and weather-related disasters (IPCC, 2021). Human-caused greenhouse gases are the main cause of global warming. These gases are emitted from fossil fuels such as coal, oil or natural gas. In addition, fossil fuels and industry contributed 89% of global CO2 emissions in 2018 (IPCC, 2021). Oil is considered a significant source of carbon when burned - about one-third of the world's total carbon emissions. Although natural gas is a cleaner energy source than coal and oil, it is still a fossil fuel and accounts for 20% of total global CO2 emissions (Clarke et al., 2021).

Therefore, countries have made strong commitments and implemented policies to reduce global greenhouse gas emissions and protect the Earth. The Paris Agreement has set an important goal: "limiting the global temperature increase to 1.5°C above pre-industrial levels". If the global temperature increases beyond 1.5°C, natural areas and ecosystems will be severely and irreversibly degraded, and climate change will have particularly serious consequences for the planet. To achieve this goal, global CO2 emissions need to be halved by 2030 and reach net zero emissions by 2050 (IEA, 2022).

To address the challenges of climate change mitigation as well as sustainable energy supply and use, a transition to a low-carbon economy is necessary. Low-carbon economic strategies seek to achieve socio-economic development and environmental protection goals while reducing greenhouse gas emissions in the long term. Transitioning to a low-carbon economy on a global scale can bring significant benefits to both developed and developing countries. Many countries around the world are designing and implementing low-carbon economic development strategies. This requires awareness and engagement of stakeholders at all levels with smart and sustainable solutions, especially in the energy sector.

Over the past 40 years, Vietnam has achieved encouraging socio-economic development achievements. Economic and political reforms introduced in 1986 have promoted rapid economic growth and development, transforming Vietnam from one of the poorest countries in the world to a dynamic emerging market. However, Vietnam faces increasingly serious risks from climate change, threatening its goal of becoming a high-income economy by 2045. 100 million Vietnamese people are among the most vulnerable in the world to the ravages of climate change (World Bank Group, 2022). It is estimated that Vietnam will face significant economic losses due to extreme climate events. Currently, the Vietnamese economy suffers losses of about 10 billion USD, equivalent to 3.2% of GDP annually due to the impacts of climate change and if no action is taken, economic losses due to climate change could reach 14.5% of GDP by 2050 according to the World Bank forecast (World Bank Group, 2022). In that context, the government issued the National Strategy on Climate Change to 2050 on 27 July 2022, detailing the country's strategy to achieve a commitment to net zero emissions. In this strategy, Vietnam aims to reduce greenhouse gas emissions by 43.5% by 2030 compared to the business-as-usual scenario with international support, and peak emissions by 2035, then reach Net Zero by 2050 (Prime Minister of Vietnam, 2022).

Over the years, Vietnam's energy sector has made positive contributions to the country's socio-economic development, but is facing many challenges, especially heavy dependence on fossil fuels, leading to environmental pollution and greenhouse gas emissions. The requirements for environmental pollution reduction and climate change response from the energy sector will become increasingly stringent and pose a major challenge to the sustainable development of Vietnam's energy system. Developing a low-carbon economy by promoting the development of renewable energy will be the main direction of Vietnam's energy sector.

2. Liratature review

The term low carbon economy was first introduced in the UK Department of Trade and Industry's Energy Policy Report in 2003, "Our Energy Future - Creating a Low Carbon Economy", in which the low carbon economy places a special emphasis on reducing greenhouse gas emissions to combat climate change (DTI, 2003). A low carbon economy is an economy in which growth is the result of integrating all aspects of the relevant economy, adopting energy efficiency and renewable energy solutions, innovating low carbon technologies, and creating energy and material efficient communities, buildings, transport, industry and agriculture, as well as increasing waste treatment/recycling to reduce greenhouse gas emissions, especially CO2 (RSC, 2011). Thus, a low-carbon economy is an economy characterized by activities that emit low levels of CO2 into the atmosphere.

The IPCC Fifth Assessment Report (IPCC, 2014) confirms that the impacts of climate change are increasing, largely due to human-caused greenhouse gas emissions. New innovations and policies focused on the need to support a low-carbon economy are important for every country in the world.

With nearly three-quarters of human-caused greenhouse gas emissions coming from the energy sector, a transition to clean, renewable energy sources is essential to addressing the climate crisis. Increased fossil fuel consumption has two potential impacts. One is the increase in carbon dioxide and other greenhouse gases, which contribute to global warming. For example, 99% of the world's coral reefs are predicted to disappear if temperatures rise by 2°C. The irreversible loss of the Greenland ice sheet could result from global warming of around 1.5°C to 2°C. This would eventually lead to further sea level rise that would directly impact coastal areas around the world, including low-lying areas (European Commission, 2018).

Renewable energy, which is energy generated from natural resources that are not limited or renewable in a short period of time compared to the time it is used. Renewable energy not only helps to reduce the negative impact on the environment compared to traditional energy sources such as coal and oil, but also helps to reduce dependence on non-renewable resources and reduce the risk of energy price fluctuations (IEA, 2022).

According to IEA (2022), renewable energy includes solar energy (using sunlight to generate electricity through solar panels), wind energy (using the wind to rotate the blades of mechanical roads to generate electricity), water energy (using flowing water to rotate turbines and generate electricity), geothermal energy (using the temperature from the ground to generate electricity), biomass energy (using energy sources from organic materials such as wood, bagasse, or waste to generate energy) and marine energy (using the power of ocean waves or seawater to generate electricity). According to Zou et al. (2016): The wind, sun, waste, water, and heat from the earth are all abundant sources of renewable energy that replenish themselves naturally with little to no air pollution or greenhouse gases being released into the atmosphere.

According to the International Renewable Energy Agency (IRENA), by the year 2050, ninety (90) percent of the world's electricity will be generated from renewable energy sources. With the help of renewable energy sources, nations may diversify their economies, shield themselves from the erratic price fluctuations of fossil fuels, and promote inclusive development, job creation, and the reduction of poverty (Aleklett et al., 2010). Renewable energy plays an important role in reducing greenhouse gas emissions and protecting the environment, while helping to ensure energy security and sustainability of energy supplies in the future (Strielkowski et al., 2021).

The economic and political frameworks necessary to promote the wide adoption and long-term viability of markets for renewable energy systems are rapidly changing (Sawin et al., 2016). It is becoming increasingly obvious that the new regime of renewable energy and, to a lesser degree, natural gas-based systems will be the primary drivers of future growth in the energy sector, as opposed to conventional oil and coal sources (Garba & Adamu, 2021).

3. Methods

To comprehensively assess the promotion of low-carbon economy through renewable energy development and practices in Vietnam, the paper collects data from primary and secondary data sources for both quantitative and qualitative analysis. From there, it creates a basis for evaluating policies implemented in the world and in Vietnam. These policies are evaluated not only based on technical and economic performance but also on social acceptance and environmental impact.

4. Results

4.1. Developing renewable energy to move towards a low-carbon economy at global level

The history of energy transition has taken place over the past 200 years. Until the mid-19th century, traditional biomass, burning solid fuels such as wood, crop residues and charcoal, was the world's main source of energy. With the industrial revolution, coal fuel played an increasingly important role. This is reflected in the increasing share of coal in the global energy mix, increasing from 1.7% in 1800 to 47.2% in 1900. In the late 19th to 20th centuries, the world's energy mix was supplemented by oil, gas and later hydropower and nuclear power. Solar and wind energy, often referred to as “modern renewable energy”, appeared later (in the 1980s) (Ritchie, 2023). Thus, renewable energy is the latest energy source to appear in the history of over 200 years, born with the mission of helping countries around the world move towards a low-carbon economy.

Emissions of greenhouse gases, especially CO2 from fossil fuel combustion, are considered the main cause of climate change. If greenhouse gas emissions from both the energy supply and demand sides are considered, energy-related greenhouse gas emissions (mainly CO2 and a small part of CH4, N2O) account for about 70% of total global greenhouse gas emissions (IEA, 2016).

According to IEA (2020), CO2 emissions from the energy sector have continuously increased over time, from 20.5 billion tons (in 1990) to 21.3 billion tons (in 1995), 23.2 billion tons (in 2000), 27 billion tons (in 2005), 30.5 billion tons (in 2010), 32.4 billion tons (in 2015) and 32.8 billion tons (in 2017). Looking at CO2 emissions by fossil fuel type, CO2 emissions from coal combustion accounted for 44.2% of total CO2 emissions, followed by oil combustion (34.6%) and natural gas combustion (20.5%) in 2017. Electricity and heat produced from coal combustion accounted for 72.6% of CO2 from electricity and heat production; while electricity and heat produced from natural gas combustion accounted for 22% and oil combustion for 5.4%. Coal-fired electricity production accounted for 30% of total global CO2 emissions. Thus, coal is the fossil fuel that generates the largest amount of CO2 emissions.

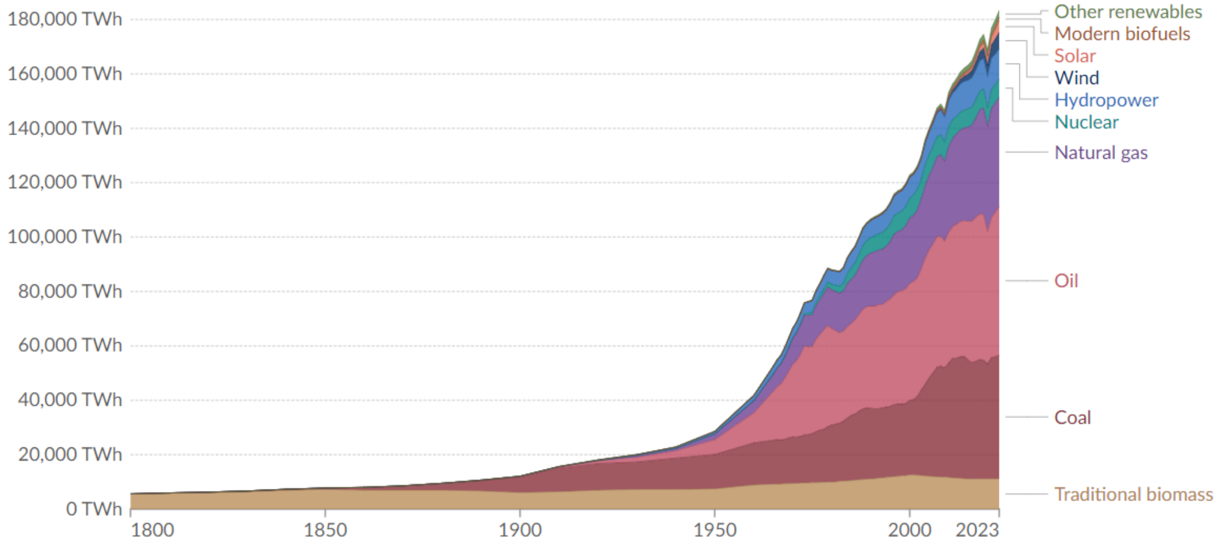

Figure 1: Global primary energy consumption by source, 1800 - 2023

Source: Ritchie (2023)

The International Energy Agency (IEA) has assessed the impact of fossil fuel use on the increase in global average temperature. The IEA found that CO2 emissions from coal combustion are responsible for 0.3°C of the approximately 1°C increase in global average temperature compared to pre-industrial levels. This makes coal the energy source that contributes the most to global average temperature increases (IEA, 2020). As a result, governments around the world are now engaged in efforts to reduce greenhouse gas emissions from fossil fuels to prevent the worst impacts of climate change and move towards a low-carbon economy. Renewable energy sources are now at the heart of the ongoing energy transition. Solar and wind power capacity is expanding around the world as countries step up efforts to curb emissions.

Table 1: Share of renewable energy in the global energy structure 2000 - 2020 (%)

Year	Traditional Biomass	Renewables	Fossil Fuels	Nuclear Power
2000	10.2	6.6	77.3	5.9
2005	8.7	6.5	79.4	5.4
2010	7.7	7.7	79.9	4.7
2015	6.9	9.2	79.9	4.0
2020	6.7	11.2	78.0	4.0

Source: Bhutada, 2022

In the decade between 2000 and 2010, the share of renewables increased by just 1.1%. But the growth is speeding up-between 2010 and 2020, this figure stood at 3.5% (Bhutada, 2022).

Efforts to address climate change are changing the way the energy sector develops, with the transition to low-carbon development pathways widely seen as an inevitable trend in the coming period through the development of low-carbon technologies, energy transition, and the development of market instruments to promote the development of a low-carbon economy. Technological change in the energy sector is central to the transition to a low-carbon economy, with the development of economically viable low-carbon technologies that will help reduce the cost of achieving climate goals, including carbon capture and storage technologies, technologies that produce goods with less or even zero carbon, more efficient equipment and vehicles, or better insulation for homes and offices. One of the ways to reduce and eliminate CO2 is to switch from the most carbon-intensive fuels (coal) to less carbon-intensive fuels (renewable energy) (DTI, 2003; RSC, 2011; IPCC, 2014).

At the same time, changing the behavior and lifestyle of individuals in society towards a low-carbon society such as reducing demand for high-emission goods and services, reducing travel, using public transport instead of driving private cars or switching from gasoline-powered cars to electric cars, changing the way of heating and cooling... Changing the behavior and lifestyle of individuals towards a low-carbon society is being promoted globally. According to the IEA (2016) assessment, positive behavioral changes will help reduce annual CO2 emissions by 3.5 to 5.0 billion tons by 2030 - accounting for 8% of the required reduction.

4.2. Practices of developing renewable energy towards a low-carbon economy in Vietnam

During the reform period, Vietnam has achieved many important achievements, becoming one of the countries with the highest economic growth rate in the region and the world. However, the country's rapid economic growth, urbanization and industrialization have relied on energy produced from coal, an energy source that emits significant greenhouse gas emissions. Although it does not contribute much to global greenhouse gas emissions with a proportion of only 0.8% of the world's emissions, in just the past two decades, Vietnam has emerged as one of the countries with the fastest growing per capita greenhouse gas emissions in the world. During the period 2000 - 2015, when the average gross domestic product (GDP) per capita increased from 390 USD to 2,000 USD, carbon dioxide (CO2) emissions also increased nearly fourfold. Viet Nam has the fastest increase in greenhouse gas (GHG) emissions in the Greater Mekong Sub-region. According to the emission scenario, the GHG emissions of Viet Nam are forecasted to reach up to 1,495.4 million tons of CO2eq by 2050, in which the energy sector accounts for 81% of the total GHG emissions (WWF, 2023, A). Furthermore, Vietnam’s greenhouse gas emissions are linked to air pollution that is harmful to human health and labor productivity and is rampant in many cities, especially Hanoi (World Bank Group, 2022).

Viet Nam’s energy sector has experienced signifcant growth over the past decade with coal, oil and gas comprising a majority share of the country’s energy supply (WWF, 2023, A). Vietnam is heavily dependent on fossil fuels. Fossil fuels accounted for 78.4% of Vietnam’s total primary energy supply in 2017. Among fossil fuels, coal plays an important role as the proportion of coal in total primary energy supply increased from 15% (in 2000) to 35% (in 2015) and 37.8% (in 2017) (MOIT, 2017; EREA & MOIT, 2019). Power plants consumed the most coal (accounting for 53.6%), followed by industries such as cement, fertilizers and chemicals (accounting for 40%) in 2015 (MOIT, 2017). The share of coal used for power generation is expected to increase from 32% in 2014 to 54% in 2030 while about 60% of the coal used for power generation will be imported (World Bank and Ministry of Planning and Investment, 2016). The shift to fossil fuels is the main reason for the increase in greenhouse gas emissions in Vietnam. Over the past decade, Vietnam has had the highest greenhouse gas emissions in the ASEAN region. Total greenhouse gas emissions and per capita greenhouse gas emissions in Vietnam have increased nearly 3 times over a 10-year period while carbon intensity per GDP increased by 48% (EREA & MOIT, 2019).

The dependence on burning fossil fuels such as coal and oil in electricity generation, transportation and heavy industry is a major cause of significant carbon emissions, causing climate change and serious air pollution such as NOx, SOx, and PM2.5 particles from these sources are also harmful to human health, leading to respiratory and cardiovascular problems. This dependence also leads to energy security risks, negative impacts on biodiversity and causes geopolitical conflicts related to fuel supply. Fluctuations in fossil fuel prices also affect the global economy.

Thus, the transition to clean energy has become an inevitable path for all countries, including Vietnam. The government of Viet Nam in 2015 implemented the Renewable Energy Development Strategy 2016-2030 with vision to 2050 (REDS). It set out various targets for promoting the use of energy from RE sources in Viet Nam over 2020, 2030, and 2050 targets. One of the primary objectives of this strategy is to “Develop and utilize RE sources in such a way that contributes to fulflling the objectives of sustainable environment and development of green economy”. One of the tasks to achieve the goal is that by 2030, the scale of wind and solar power will need to increase 4 times and energy efficiency will need to be greatly improved compared to today.

Faced with this situation, Vietnam has adopted preferential policies to promote renewable energy. The Vietnamese government has continuously demonstrated its determination by setting ambitious renewable energy development targets.

Table 2: Overview of key strategies and plans on renewable energy in Vietnam in 2020 – 2024

References	Focus Areas	Renewable Energy Targets
National energy development strategy orientation, Resolution 55-NQ/TW (2020)	Strategic orientation for the development of Vietnam's energy system to 2030, vision to 2045	Renewable energy share in TPES: 15-20% by 2030; 25-30% by 2045. Emission reduction target in the entire energy sector: 15% by 2030, 20% by 2045.
National Strategy on Climate Change (2022)	Climate change adaptation and greenhouse gas emission reduction strategy, targeting net zero emissions by 2050 through clean and efficient energy technologies	Renewable energy share in electricity generation: at least 33% by 2030 and 55% by 2050.
Partnership Agreement for a Just Energy Transition (2022)	International support for Vietnam to achieve net zero emissions target by 2050 and 2030	- Renewable energy share in electricity output: 47% (2030). - Coal power capacity: 30.2 GW (2030)
National power development plan for the period 2021-2030, vision to 2050 (2023)	Power industry planning to 2030, vision to 2050	Renewable energy share in electricity output: 31-39% in 2030 (up to 47% if JETP commitment is implemented) and 67.5-71.5% in 2050.
National energy master plan for the period 2021-2030, vision to 2050 (2024)	Energy sector planning on fuel structure development to 2050	Energy sector-wide emissions target: 399-449 million tonnes CO2eq in 2030 and 101 million tonnes CO2eq in 2050.

Source: Communist Party of Vietnam, 2020; Prime Minister of Vietnam, 2022; Dang et al., 2022; Prime Minister of Vietnam, 2023; Prime Minister of Vietnam, 2024

The shift from fossil energy to renewable energy is an inevitable trend in the world, aiming to achieve the goal of reducing greenhouse gas emissions while bringing many economic benefits. Vietnam has many advantages in developing renewable energy such as hydropower, solar energy, geothermal energy, wind energy, biomass energy, etc. However, the path to achieving these goals is not smooth, Vietnam has to face many difficulties and challenges.

Table 3: Advantages, difficulties and potential of renewable energy in Vietnam

Type	Cost	Advantages and Disadvantages	Sustainability	Potential
Large-scale hydropower	Cheap energy source due to well-established technology	Large and flexible power supply. Output may be affected by water levels and climate change	Significant environmental and social impacts and risks (biodiversity, displacement, landslides, local livelihoods)	No longer a potential in Vietnam for large hydropower projects
Small and micro-scale hydropower	Affordable, advanced and well understood technology	Production may be affected by water levels and climate change	Environmental and social impacts and risks similar to large hydropower projects (at a lower level)	Potential remaining at around 2-3 GW (3.6 GW installed)
Solar power plants	Low cost and levelised cost of electricity has been falling over the years	Energy supply is intermittent as no power can be generated at night unless there is storage	Low carbon emissions, but end-of-life management processes are unclear in Vietnam	50 GW including ground-mounted and rooftop solar plants
Rooftop solar power	Low cost and no additional land or transmission lines required, but	Energy supply is intermittent as no power generation at	Low carbon emissions, but end-of-life management processes are unclear in Vietnam	High potential with Direct Power Purchase Agreements

Type	Cost	Advantages and Disadvantages	Sustainability	Potential
	capacity is not as good as ground-mounted solar power plants	night unless storage is provided		
Onshore wind power	Low cost and levelised cost of electricity has been falling over the years	High capacity and output if sited well. However, output is intermittent due to wind regimes	Low carbon emissions, but environmental and social risks and impacts (noise, flickering lights, visual impact, bird and bat collisions)	Technical potential 40-90GW
Offshore wind power	Higher investment costs and risks than onshore wind, many technical challenges	Energy sources are volatile but more stable than onshore wind due to the influence of wind regime	Low carbon emissions. Environmental and social risks and impacts are not well understood (marine life and birds)	Technical potential 500-600 GW
Biomass	Currently only a few plants with limited capacity are being developed	Challenges in securing fuel supply	Risks of converting agriculture to monoculture, which could threaten food supply, farmers' livelihoods and deforestation	Technical potential 7GW

Source: WWF, 2023b

Thanks to favorable potentials, in recent years, renewable energy in Vietnam has made significant progress, especially solar power and wind power (solar power increased by 5.22% and wind power increased by 3.47% in the proportion of the entire electricity industry within 4 years from 2020 to 2024).

However, Vietnam faces many challenges in its transition to a low-carbon economy. Financial constraints are one of the biggest barriers, especially as investment in renewable energy infrastructure requires large capital and long-term commitment. Improving institutional capacity to manage and operate a complex and modern energy system is also a significant challenge, requiring improvements in planning, management and engineering.

In addition, the national grid infrastructure is a challenge for growth in the renewable energy sector. Transmission infrastructure has not kept pace with capacity growth, causing constraints. The rapid development of renewable energy projects has caused grid overload. Wind and solar power plants in many provinces will have to reduce output to maintain grid stability. Renewable energy development is not synchronized with the transmission system, leading to waste of resources.

Along with that, there are no national technical standards and regulations on solar and wind power systems. Domestic technological capacity and level are still limited, lacking technical infrastructure and support services for repair, maintenance and replacement of equipment. The rate of localization of energy industry technology is low, lacking support mechanisms and promoting localization of technology.

Table 4: Output and proportion of mobilized power sources across the system in the first 6 months of 2020 and 2024

First 6 months of 2020			First 6 months of 2024		
Type	**Output (billion kWh)**	**Proportion (%)**	**Type**	**Output (billion kWh)**	**Proportion (%)**
Hydropower	21,55	18,04	Hydropower	28,63	18,86
Coal-fired power	69,77	55,9	Coal-fired power	86,34	56,89
Gas turbines	19,24	16,11	Gas turbines	13,12	8,64
Solar power	4,71	3,94	Solar power	13,91	9,16
Wind power	0,7	0,58	Wind power	6,15	4,05
Oil-fired power	1,04	0,87	Oil-fired power	2,56	1,68

Source: EVN, 2020; EVN, 2024

4. Conclusion

Faced with the enormous impact of climate change, more and more countries are committing to achieving net zero emissions targets. The Net Zero Tracker report confirms that 128 countries and autonomous territories, accounting for 91% of global greenhouse gas emissions, have committed to achieving net zero (Net Zero Tracker, 2023). As a member of the Paris Agreement, Vietnam has also committed to achieving net zero emissions by 2050.

In Vietnam, the energy sector is responsible for 2/3 of total greenhouse gas emissions, but it is also the sector with the highest potential for emission reduction. Gradually reducing dependence on coal, aiming for complete elimination by 2050, and switching to renewable energy plays an important role in the process towards the goal of net zero emissions. Vietnam has many natural geographical potentials that are ideal for the development of the renewable energy industry, especially solar and wind power. If it maintains the rapid expansion of renewable energy, Vietnam will be able to surpass many countries in terms of renewable energy development solutions and innovation. However, this process also faces many difficulties and challenges.

The energy transition needs to be concerned in 4 areas: Availability of energy sources; accessibility to energy sources in regions; affordability of people and acceptance of energy types in localities and people. With the goal of ensuring energy security, providing energy at acceptable costs and implementing Vietnam's environmental protection commitments to the international community, Vietnam needs to integrate harmoniously and have a roadmap for the development of renewable energy technology, with incentives to promote energy efficiency technology to successfully implement the energy transition in Vietnam.

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Developing Carbon Pricing Mechanisms in Vietnam: Opportunities and Challenges

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Abstract

Climate change poses a significant threat to global sustainable development, with Vietnam being particularly vulnerable to its impacts. As the country aims to reduce greenhouse gas emissions, carbon pricing mechanisms and carbon market development have emerged as potentially effective policy tools. This study examines the significance of fostering carbon pricing mechanisms in Vietnam within the context of an emerging carbon market. Through a comprehensive literature review, this paper analyzes international experiences and Vietnam's current situation. It explores the potential opportunities and challenges in implementing carbon pricing tools in Vietnam, with a focus on the energy sector as identified in the country's updated Nationally Determined Contribution (NDC). Findings indicate that while Vietnam has significant potential for carbon market development, particularly in the energy sector, the current market is still in its early stages. The study identifies key factors necessary for developing effective carbon pricing tools in Vietnam, including a robust legal framework, transparent Monitoring, Reporting, and Verification (MRV) systems, and strong institutional capacity. This analysis contributes to the ongoing discussion on climate change mitigation strategies in Vietnam, offering insights for policymakers and stakeholders involved in the country's transition to a low-carbon economy. The implementation of well-designed carbon pricing mechanisms could not only aid in achieving Vietnam's emission reduction targets but also promote green growth and enhance the country's global standing in climate action.

Keywords: *Carbon pricing, climate change mitigation, emissions trading system, green economy, Vietnam environmental policy*

1. Introduction

In the 21st century, the global community faces numerous challenges, with climate change emerging as one of the most formidable. A report from Vietnam's Ministry of Natural Resources and Environment, published in 2020, presents a sobering outlook for the country. The study indicates that throughout this century, Vietnam is likely to experience a consistent increase in both average temperatures and sea levels. These changes are expected to be accompanied by alterations in precipitation patterns, a higher frequency of extreme weather events, and an elevated risk of coastal flooding (MONRE, 2020). These findings underscore the pressing need to bolster climate change mitigation strategies, with particular emphasis on implementing carbon pricing mechanisms and fostering a robust carbon market. In its 2022 revision of the Nationally Determined Contribution (NDC), Vietnam has established a bold target for curtailing greenhouse gas emissions. The country pledges to decrease emissions by 15.8% relative to the business-as-usual (BAU) scenario by 2030. This figure could potentially rise to 43.5% with international assistance. Realizing this ambitious objective necessitates the swift development and efficient deployment of carbon pricing mechanisms, alongside the cultivation of a thriving carbon market. These measures have taken on heightened importance, particularly given the critical role of the energy sector in Vietnam's broader emission reduction strategy (MONRE, 2022).

Vietnam has demonstrated a strong commitment to responding to climate change through the development and implementation of policies and strategies on green growth and emission mitigation. Vietnam's approach to addressing climate change has been shaped by several key policy documents. The National Green Growth Strategy, introduced in 2012, and its associated Action Plan, launched in

2014, established the groundwork for the country's climate mitigation efforts. Further reinforcing this commitment, the revised NDC of 2020 places strong emphasis on leveraging market-driven mechanisms to facilitate the transformation of the industrial landscape. Moreover, the 2016 roadmap for implementing the Paris Agreement highlighted the cultivation of a domestic carbon market as a priority. This plan also stressed the importance of conducting pilot programs in high-potential sectors during the 2016-2020 period (USAID, 2018).

The World Bank's latest analysis, "State and Trends of Carbon Pricing 2023", offers an encouraging perspective on the resilience of carbon pricing mechanisms. Despite the challenges posed by a worldwide energy crisis and escalating inflation rates, the report indicates that instruments like carbon taxes and emissions trading systems (ETS) are showing continued positive growth and development. As of April 2023, 73 carbon pricing instruments have been implemented or planned, covering about 23% of global greenhouse gas emissions. Carbon prices have risen in half of the ETS and carbon taxes, showing the stability of these tools in the face of the energy crisis. Many emerging countries are showing interest in applying market-based tools to reduce emissions, manage risks in the transition process, seek revenue-generating opportunities, and prepare for the process of joining the European Union (World Bank, 2023).

To realize its ambitious objective, Vietnam must employ a multifaceted approach comprising various coordinated strategies. Chief among these are the creation and deployment of carbon pricing mechanisms, as well as the nurturing of a robust carbon market, both of which are regarded as crucial and efficacious policy instruments. Globally, numerous nations have effectively utilized carbon pricing tools, such as carbon taxes and emissions trading systems (ETS), in their endeavours to curtail emissions and facilitate the shift towards a low-carbon economic model (World Bank, 2021, A).

This study seeks to examine the significance of establishing carbon pricing mechanisms in Vietnam against the backdrop of an evolving carbon market. The research endeavors to evaluate the present landscape, explore potential opportunities, and put forward targeted recommendations for the successful deployment of these instruments. Through researching and synthesizing international documents, reports, and experiences, the article will provide useful information and recommendations for the Vietnamese Government in the process of formulating policies and actions to respond to climate change.

2. Methods

This study employs a comprehensive narrative literature review approach to examine carbon pricing mechanisms and carbon market development globally and in Vietnam. The research process comprises five key stages.

Table 1: Five main stages of the research process

Stage	Description	Criteria/Tools
Stage 1: Defining Research Questions and Scope	Formulate three main questions focusing on international experiences in carbon pricing, the current status in Vietnam, and potential for implementation.	Focus on relevance to Vietnam's context and global best practices
Stage 2: Literature Search	Conduct a thorough search of academic databases, official reports, and policy documents from 2010 to 2023.	Keywords include 'carbon pricing', 'carbon tax', 'emissions trading', 'Vietnam'.
Stage 3: Screening and Selection	Evaluate and select relevant literature based on predefined criteria.	Relevance to research questions, reliability of sources, recency of information, and diversity of perspectives.
Stage 4: Analysis and Synthesis	Extract key information from selected sources and synthesize findings.	Use content analysis techniques to identify common themes, trends, and insights.
Stage 5: Review and Finalization	Critically review the synthesized information and finalize the analysis	Cross-reference findings with initial research objectives, ensure logical consistency, and validate conclusions.

Source: Compiled by the author

This methodology ensures a thorough exploration of the topic, drawing from diverse and reliable sources to provide a comprehensive analysis of carbon pricing mechanisms in the context of Vietnam. By following this structured approach, we aim to offer valuable insights for policymakers and stakeholders involved in Vietnam's transition to a low-carbon economy.

Limitations of the study include reliance on secondary data sources and potential gaps in domestic research on carbon pricing in Vietnam. Future research could benefit from incorporating primary data collection methods, such as interviews with experts and policymakers, to supplement the literature-based analysis.

3. Results

3.1. International experience in developing carbon pricing tools and carbon market

Notwithstanding the challenges posed by worldwide energy shortages and escalating inflation rates, mechanisms for pricing carbon, including taxation and emissions trading schemes (ETS), have shown resilient growth (World Bank, 2023). According to the World Bank's report (2023), as of April 2023, 73 carbon pricing tools have been implemented or planned, covering about 23% of global greenhouse gas emissions. Carbon prices have risen in half of the ETS and carbon taxes, showing the stability of these tools in the face of the energy crisis.

The International Climate Action Partnership (ICAP) has released its "Emissions Trading Worldwide: Status Report 2023" which underscores the significant expansion and development of emissions trading schemes (ETS) globally. Since the inaugural report in 2014, the number of ETSs has more than doubled, increasing from 13 to 28 systems. Concurrently, the proportion of global emissions covered by ETSs has risen from 8% to 17%, demonstrating the widespread adoption and development of carbon pricing mechanisms globally (ICAP, 2023, A).

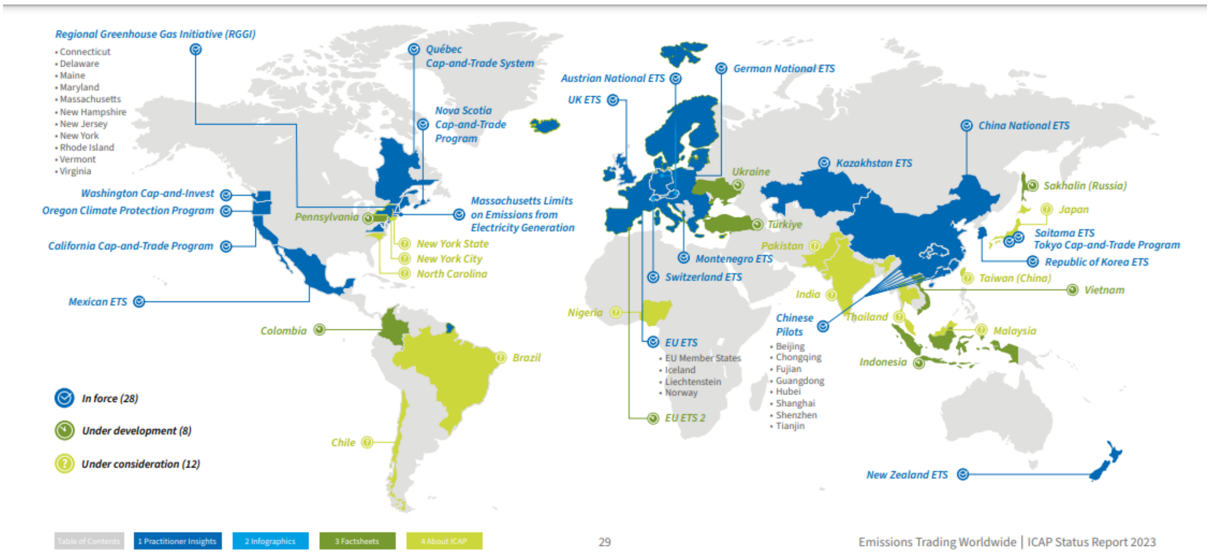

Figure 1. The ICAP ETS world map in 2023

Source: ICAP, 2023a

The ICAP ETS world map (Figure 1) provides a comprehensive overview of the current state of emissions trading systems, illustrating those that are currently operational, under development, or being considered. As of January 2023, 28 ETSs are in force, with an additional eight systems in development, expected to become operational in the coming years. Notable examples of jurisdictions with ETSs in development include Colombia, Indonesia, and Vietnam. Furthermore, twelve jurisdictions are evaluating the potential integration of ETSs into their climate change policies, including Nigeria, marking the first African jurisdiction on the map (ICAP, 2023, A).

The map also details jurisdictions with multiple systems in place, depicted in blue with borders representing the layered systems (e.g., Germany and Guangdong). Additionally, jurisdictions that have existing systems and are developing new ones are shown in blue with green borders, exemplified by the European Union (EU) (ICAP, 2023, A).

The majority of existing carbon pricing mechanisms are predominantly implemented in affluent nations across North America and Europe, spanning national, state, and regional jurisdictions. These economically advanced countries also tend to impose the most substantial carbon prices. In contrast, the Middle East and African region has seen limited adoption, with only a single mechanism currently in place. However, numerous African nations are exploring potential options and initiating preliminary groundwork (World Bank, 2023). Developing economies are increasingly drawn to these tools, driven by several factors: the imperative to establish climate change mitigation strategies, the need to navigate transition-related risks, the pursuit of new revenue streams, and, for some, the aspiration to align with European Union standards in preparation for potential membership (World Bank, 2023).

According to the World Bank's 2023 analysis, policymakers face the ongoing challenge of harmonizing multiple objectives when instituting carbon pricing mechanisms. These goals include enhancing fiscal income, fostering public approval, and safeguarding international economic competitiveness. The report reveals that approximately 40% of the funds generated through emissions trading schemes (ETS) and carbon levies are channeled into environmentally-friendly initiatives. An additional 10% is allocated to offset the impact on households and businesses, a strategy aimed at bolstering support for these measures. As governments grapple with mounting budgetary constraints, the revenue-generating capacity of carbon pricing instruments is garnering increased.

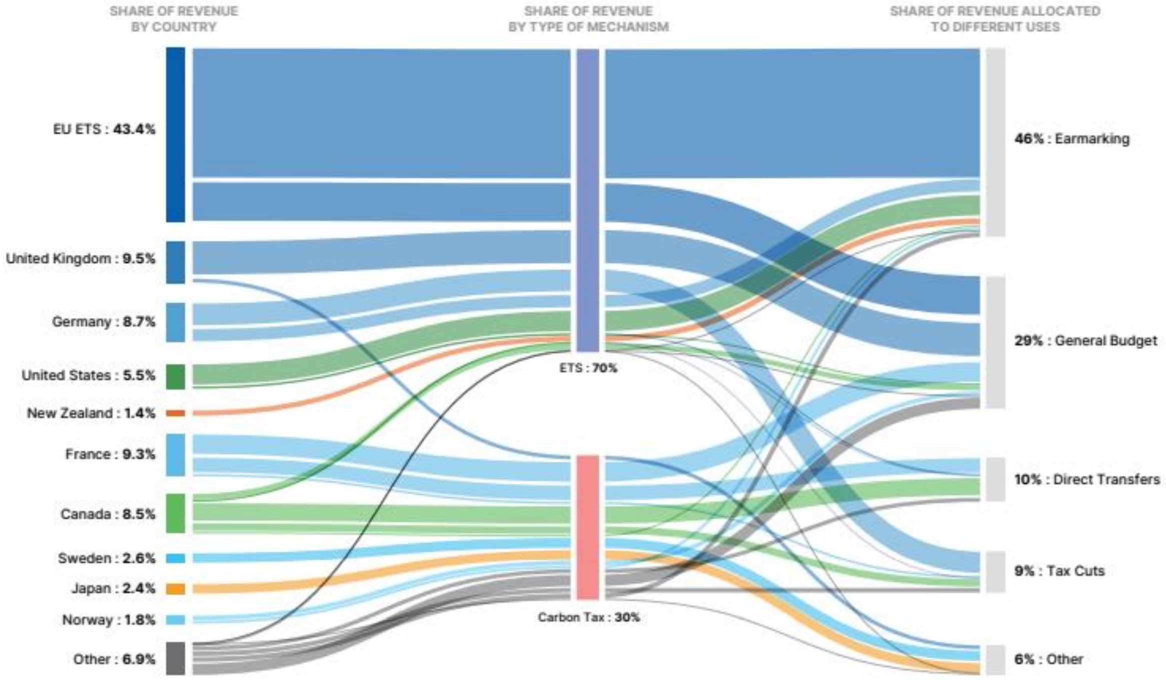

Figure 2: Scale and uses of carbon revenue in 2021

Source: World Bank, 2023

The year 2021 saw unprecedented financial returns from carbon pricing mechanisms, with combined proceeds from emissions trading schemes (ETS) and carbon levies approaching 100 billion USD. This record-breaking sum was distributed across several key players: The European Union's ETS contributed the lion's share at 43.4%, followed by significant portions from the United Kingdom (9.5%), France (9.3%), Germany (8.7%), and Canada (8.5%). The United States also made a notable contribution, accounting for 5.5% of the total. More than 70% of revenue comes from ETS and 30% comes from carbon taxes (Figure 2) (World Bank, 2023).

In addition to ETS and carbon taxes, the voluntary carbon credit market also plays an important role. According to the World Bank (2023), although the volume of credits issued and retired decreased slightly compared to 2021, it is still significantly higher than previous years. The carbon credit market continues to be primarily propelled by voluntary corporate participation. However, regulatory compliance is steadily gaining significance as a market force. The landscape is further enriched by an influx of novel stakeholders, including fresh investors, innovative financial instruments, cutting-edge technological platforms, and specialized service providers. This diversification is establishing a robust framework for substantial expansion of the carbon credit marketplace over the coming ten years. Many initiatives seek to promote standardization and transparency of the market, encourage market growth, while ensuring the integrity of emission reduction actions from businesses (World Bank, 2023).

The implementation of Article 6 from the Paris Agreement is gaining momentum as an increasing number of nations forge bilateral partnerships and initiate pioneering projects that yield transferable emissions reduction results. This trend signifies progress in the global effort to operationalize the Agreement's mechanisms for international cooperation on climate action. (World Bank, 2023). Overall, despite difficulties, carbon pricing tools around the world are proving their relevance and effectiveness in promoting emission reduction, clean energy transition, and mobilizing resources for climate action (ICAP, 2023, A; The World Bank, 2023). The evolution of carbon pricing mechanisms, coupled with the expansion of the carbon credit marketplace, is creating significant prospects for nations across the economic spectrum. Both industrialized and emerging economies stand to benefit as they navigate the transition towards a more sustainable, low-emission economic model (World Bank, 2023).

Countries around the world have had a lot of experience in developing and operating carbon pricing tools as well as developing the carbon market. Here are some typical examples:

New Zealand: Since its inception in 2008, the New Zealand Emissions Trading Scheme (NZ ETS) has served as a cornerstone of the nation's strategy to curb greenhouse gas emissions. The NZ ETS covers about 50% of total emissions, including the forestry, energy, industry, liquid fuels, waste, and synthetic greenhouse gases sectors (ICAP, 2023, B). The emission cap is set on a trajectory to achieve the goal of carbon neutrality by 2050. Allowances are mainly allocated through auctions from 2021. New Zealand has implemented many reforms to improve the NZ ETS, such as adjusting the cap reduction trajectory, increasing the auction floor price, and expanding the market stability mechanism (ICAP, 2023, B).

Korea: In 2015, Korea pioneered the implementation of a comprehensive, nationwide carbon market in East Asia with the launch of its Emissions Trading Scheme (K-ETS). This initiative marked the region's first obligatory emissions trading program at a national scale. The K-ETS covers about 74% of national emissions, including the energy, industry, construction, waste, transportation, and domestic aviation sectors (World Bank, 2023). A minimum of one-tenth of emission permits are distributed through auction mechanisms. Sectors vulnerable to carbon leakage receive complimentary allowances, with allocations determined by their emission performance standards and level of trade exposure (ICAP, 2023, C). Korea has carried out several reforms such as increasing incentives for emission reduction for efficient businesses, promoting trading to limit price volatility, and supporting small and medium-sized enterprises to participate in the market (ICAP, 2023, C).

China: The nationwide carbon trading program in China, known as the China national Emissions Trading Scheme (ETS), commenced operations in July 2021. This initiative represents the most extensive emissions marketplace globally, estimated to cover more than 4 billion tons of CO_2, accounting for more than 40% of total national emissions (ICAP, 2023d). In the initial phase, the system applies to more than 2,000 coal and gas power plants with output exceeding 26,000 tons of CO_2, allocated based on emissions benchmarks and actual output (ICAP, 2023, D). Compliance obligations are still limited and differentiated by the type of power generation. China will expand the scope to other sectors in the future. In 2022, China updated the MRV guidelines, tightened the emission benchmarks for coal-fired power generation, and proposed adjusting the allocation for the period 2021-2022 (ICAP, 2023, D).

Washington, USA: Washington's "cap-and-invest" program officially started operating from January 2023, covering about 70% of the state's emissions, including the energy, industry, construction, and transportation sectors (ICAP, 2023, E). The planned decline in the emissions ceiling aligns with the long-term objective of achieving a 95% reduction in greenhouse gas outputs by 2050, relative to 1990 benchmark levels. Allowances are allocated through auctions and free allocation based on emission benchmarks (ICAP, 2023, E). The system has market stability reserve mechanisms and auction floor prices. Washington has applied many design elements similar to California's program and is considering the possibility of linking markets (ICAP, 2023, E).

Québec, Canada: Québec's Emissions Trading Scheme was implemented in 2013 and covers about 80% of the province's total emissions (ICAP, 2023, F). The system applies to the power generation, construction, transportation, industrial sectors, and some industrial processes, with thresholds including from 25,000 tons of CO_2/year (ICAP, 2023, F). Most emitters are allocated through auctions, while some industries at risk of carbon leakage and electricity producers are partly allocated for free. Québec also maintains a reserve to sell to entities that do not have enough allowances. Québec has linked its market with California since 2014 (ICAP, 2023, F).

These global case studies demonstrate that the efficacy and market integrity of Emissions Trading Systems (ETS) hinge on the judicious selection and crafting of several critical elements. These include the range of emissions covered, the pathway for emissions reduction, methods of allowance distribution, and mechanisms for price stability. Moreover, the success of ETS in meeting emission reduction targets and fostering sustainable growth is further bolstered by robust Monitoring, Reporting, and Verification (MRV) processes, enhanced transparency of information, provision of support to market participants, and the establishment of connections with other carbon markets.

3.2. Current situation and potential of the carbon market in Vietnam

Although Vietnam is assessed to have great potential in developing the carbon market, especially through connecting with the international market, currently this market is still in its early stages. With strong commitments in the NDC and efforts to transition to a green economy, Vietnam can attract interest and investment from countries and international organizations in the fields of emission reduction and carbon trading (MONRE, 2022).

Vietnam's updated NDC (2022) has identified the energy sector as the focus of emission reduction efforts, with 38 emission reduction measures proposed. These measures can reduce a total of 1,198 MtCO2e in the period 2021-2030 and 226.98 MtCO2e each year by 2030. This opens up great potential for the development of the carbon market in Vietnam, especially in the energy sector.

In addition, a project funded by the World Bank has supported Vietnam in assessing the feasibility and designing credit programs in the steel and urban solid waste management sectors. These programs help create a high-quality carbon credit supply, while building an MRV system (World Bank, 2021, B). This shows the potential for developing carbon credit programs in other industrial sectors.

Moreover, although not called a carbon tax, the Environmental Protection Tax Law applied to fossil fuels has partly reflected the price of carbon. However, the current tax rates vary greatly between fuel types and do not clearly take into account the carbon content. Therefore, tax reform in the direction of harmonizing tax rates between fuel types corresponding to emission levels will become a feasible step to apply a carbon tax in Vietnam (USAID, 2018).

However, to effectively exploit this potential, Vietnam needs to take specific and decisive steps in developing a legal framework, strengthening institutional capacity, and mobilizing the participation of stakeholders. At the same time, the development of the carbon market needs to be integrated and harmonized with other socio-economic development policies and goals of the country.

3.3. Necessary factors for developing an effective carbon pricing tool in Vietnam

To develop an effective carbon pricing tool in Vietnam, the following factors need to be considered:

Firstly, it is essential to adopt a holistic approach to economic price signals. The concept of carbon pricing encompasses both direct mechanisms, such as carbon levies and cap-and-trade systems, as well as indirect measures like fuel taxation and subsidy policies (Pryor et al., 2023). Currently, the carbon tax imposed on coal is significantly lower—by two orders of magnitude—compared to other fossil fuel sources. Vietnamese government projections indicate a substantial rise in coal consumption, from under

50 million tonnes in 2016 to an anticipated 150 million tonnes by 2030, potentially resulting in coal accounting for 53% of power generation. To achieve meaningful emissions reduction, it would be beneficial to standardize tax rates across all fuel types. For context, India, despite its lower economic development status compared to Vietnam, has successfully implemented a coal tax of 6 USD per tonne. In light of this, Vietnam should consider introducing a carbon tax on coal at 15 USD per tonne of CO_2. Such a pricing strategy could potentially curb the projected increase in coal usage and significantly contribute to meeting the country's Nationally Determined Contribution (NDC) mitigation targets (USAID, 2018). Nevertheless, modifying the coal tax in isolation is insufficient. What's required is a comprehensive carbon pricing framework that incorporates both direct and indirect pricing instruments.

Second, the total carbon price needs to be used as a composite measure to assess the impact of policies. The total carbon price is a combination of direct and indirect carbon prices, providing a more complete picture of the price signals affecting fossil fuel combustion. Focusing only on direct pricing can overlook other important policies that affect the carbon price (Pryor et al., 2023). The total carbon price can be used at many levels: enterprise, industry, fuel type, national, regional, and global. Therefore, it can help identify opportunities and gaps in pricing policies in each specific area (Pryor et al., 2023). This is the basis for improving the carbon pricing tool comprehensively.

Third, a preliminary analysis of the total carbon price by Pryor et al. (2023) shows that the scale of direct pricing is quite modest compared to indirect measures such as energy taxes and subsidies. The total carbon price trend largely depends on the movement of indirect prices. This situation presents an opportunity for Vietnam to leverage existing tools to improve the consistency of its carbon pricing system. For example, adjusting fossil fuel subsidies and applying a carbon tax on a gradual roadmap, starting with a low tax rate and increasing gradually, will play an important role in shifting the price signal. Implementing a carbon levy of 6 USD per metric ton of CO_2 on direct emissions from cement manufacturing and across-the-board fossil fuel consumption could yield significant financial benefits. Such a measure has the potential to boost yearly revenues from 1.6 billion USD in 2020 to an estimated 3.6 billion USD by the end of the decade in 2030 (USAID, 2018).

Fourth, the legal framework needs to be comprehensive and transparent. A stable and predictable legal framework is an important factor in establishing trust for businesses and investors to participate in the carbon market. Clear and transparent rules and procedures will promote trading and investment in the carbon market (United Nations Conference on Trade and Development, 2022).

Fifth, a critical component in maintaining the ecological credibility of any carbon crediting mechanism is the establishment of a rigorous, autonomous, and clear-cut system for monitoring, reporting, and verification (MRV). The efficacy of such a system hinges on the careful consideration of multiple elements. These include: validating the supplementary nature of emission-reducing activities, employing third-party verification for emission reduction claims, implementing safeguards against the duplicate tallying of emission cuts, and confirming the long-term sustainability of achieved emission reductions (United Nations Conference on Trade and Development, 2022). The MRV mechanism needs to be based on international standards but still suitable to the actual capacity of agencies and businesses in Vietnam. The participation of independent organizations also contributes to improving the accuracy and objectivity of information.

Sixth, the participation and cooperation of stakeholders is very important. Government agencies, businesses, and social organizations need to have a voice in the process of developing the carbon pricing mechanism (NZAOA, 2022). A broad discussion and consultation mechanism will help increase the feasibility and effectiveness of this tool. In addition, capacity building and awareness raising of stakeholders is also very necessary for them to actively and responsibly participate. Specifically, there need to be appropriate compensation and support policies for workers, businesses, and communities affected by the carbon price. Additionally, it's crucial to appropriately design the scope of tax application, taxpayers, and tax rates to both create incentives for emission reduction and avoid negative impacts on the economy. There need to be appropriate exemption and reduction measures, application thresholds for vulnerable groups, and transparent communication about the purpose of using revenue as well as solutions to minimize negative impacts (Pryor et al., 2023).

Seventh, institutional capacity needs to be strengthened. The successful implementation of carbon pricing tools and emissions trading requires the coordination of many different agencies. Therefore, the monitoring, inspection, and enforcement capacity of state management agencies, especially in the fields of economy and environment, needs to be enhanced (Dominioni, 2022). The training of high-quality human resources in the field of environmental economics and carbon finance also needs to be focused.

Eighth, it is necessary to develop a specific roadmap and action plan to implement the carbon pricing tool, in line with the country's development conditions and goals. This roadmap needs to be developed based on a thorough analysis of Vietnam's context and capacity, referencing international experiences, to ensure feasibility and effectiveness. It needs to be divided into stages with specific goals and have flexible adjustment options depending on the actual situation (Pryor et al., 2021).

Ninth, it is necessary to raise awareness and support of stakeholders and the public for carbon pricing through dialogue, consultation, and communication. The communication plan needs to show the benefits of carbon pricing, address concerns, and make information transparent to build trust. Showing listening and respect for the opinions of stakeholders will help increase acceptance of carbon pricing policies (Pryor et al., 2021). Tenth, the design of the pricing tool needs to be approached flexibly and evolutionarily, in accordance with Vietnam's development level and can be adjusted over time. For example, it can start from a low price level and emission scope, then gradually increase ambition as capacity and readiness are improved. Clearly identifying the roadmap for price increase and scope expansion will help businesses and households have time to prepare and adapt (Pryor et al., 2021).

Finally, Vietnam needs to effectively leverage international cooperation to build capacity and mobilize resources for the transition process. Sharing experiences, technical and financial support from partners can support Vietnam in effectively developing and operating carbon pricing tools, contributing to the implementation of the national greenhouse gas emission reduction target (Dominioni, 2022).

In summary, the successful development and effective operation of carbon pricing tools require careful preparation of the legal framework, MRV mechanism, institutional capacity, and participation of stakeholders. Concurrently, it is crucial to adopt a holistic perspective on economic price indicators, employing the aggregate carbon price as a metric for impact evaluation. This approach should be coupled with adaptable policy modifications and the strategic utilization of global partnerships. If designed and implemented appropriately, carbon pricing tools will not only contribute to efforts to respond to climate change but also open up opportunities to promote green growth, create sustainable jobs, and enhance the country's position in the international arena.

4. Conclusion and Recommendations

This study underscores the critical importance of carbon pricing mechanisms and carbon market development in Vietnam's pursuit of greenhouse gas emission reduction and transition to a sustainable economy. International experience demonstrates that successful implementation of carbon pricing tools requires a robust legal framework, effective MRV mechanisms, strong institutional capacity, and active stakeholder engagement. Vietnam possesses significant potential for carbon market development, particularly in the energy sector, as identified in the country's updated NDC. To effectively leverage this potential, Vietnam should prioritize enhancing the legal framework governing carbon credit trading and markets, developing a specific, phased roadmap for implementing carbon pricing tools, establishing a transparent and reliable MRV system, strengthening stakeholder participation, and building institutional capacity in carbon market management.

These measures require political commitment, resource allocation, and coordinated efforts among relevant agencies. Vietnam should actively seek international support for funding, technology transfer, and capacity building to accelerate its transition to a low-carbon economy. In conclusion, the strategic development and implementation of carbon pricing mechanisms can significantly contribute to Vietnam's climate change mitigation efforts while fostering green growth, creating sustainable employment, and enhancing the country's global standing. Future research should focus on quantitative analysis of the economic impacts of various carbon pricing scenarios and explore sector-specific implementation strategies.

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Solutions to Build a Forest Carbon Market for Green Development in Vietnam

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Abstract

Green development is an inevitable trend in the sustainable development process not only in Vietnam, but also in other countries in the world. In particular, since the Kyoto Protocol was issued, along with the correct awareness of Vietnam, as a responsible member of the international community on environmental protection and biodiversity conservation, the carbon credit market has received attention in Vietnam. In particular, developing the forest carbon credit market is considered an advantage of Vietnam, due to the advantages of area and diversity of forest species. Therefore, in recent times, with specialized environmental methods as well as interdisciplinary environmental - economic - social, etc., there have been many research projects on building a forest carbon market to serve green development in Vietnam. In order to continue to clarify, survey the current situation and propose some solutions to develop the forest carbon market in Vietnam, this study focuses on: (1) Policies related to forest carbon management in Vietnam; (2) Potential practical conditions for developing a forest carbon market in Vietnam; (3) Some challenges in developing a forest carbon market for green development in Vietnam currently; (4) Some solutions to develop the forest carbon market to serve green development in Vietnam currently.

Keywords: *Forest carbon market, green development, Vietnam*

1. Introduction

The carbon credit market appeared in 1997, when the United Nations Kyoto Protocol on Climate Change was officially adopted. According to this Decree, economies with surplus greenhouse gas emission rights are allowed to buy, sell or give these rights to other countries. This is the basis for the appearance in the world of a new commodity with a demand for trading on the market, which is certificates related to greenhouse gas emission reduction. Because CO_2 is a greenhouse gas, the equivalent conversion related to other greenhouse gases for greenhouse gas emission transactions is commonly called buying/selling, exchanging carbon certificates. From there, a carbon trading market or carbon credit market was formed. In this market, the buying and selling of greenhouse gas emissions or the buying/selling of carbon emissions is traded through the conversion unit of carbon credits.

According to Forbes Vietnam Magazine, carbon credit is a term referring to a credit unit traded in business, or a license for 1 ton of CO_2 or the volume of another greenhouse gas equivalent to 1 ton of CO_2 (abbreviated as tCO_2tđ). Thus, a carbon credit is a certificate (or license) that allows the owner to emit 1 ton of CO_2 or another converted greenhouse gas. A carbon credit limits the amount of emissions to 1 ton of CO_2. The goal of carbon credits is to gradually reduce greenhouse gas emissions into the atmosphere. In implementing the roadmap to reduce greenhouse gas emissions, economies, industries, or businesses are assigned a specific annual "quota" of emissions or a ceiling on the number of carbon units emitted (also known as Cap). This ceiling will usually be adjusted downward in the direction of reducing greenhouse gas emissions into the atmosphere. The number of carbon credits that participants are allowed to trade must be within the prescribed ceiling; if they exceed the ceiling, they will be fined. Therefore, in the case of emissions exceeding the ceiling, to avoid being fined, these entities need to buy more "rights" to emit from entities with surplus in the market. On the contrary, if they do not use up the quota of the emission ceiling, these entities can transfer it to entities in need. Since the Kyoto Protocol came into effect, the carbon credit trading market has developed strongly in developed countries. There are currently two main types of trading markets: (1) The mandatory carbon credit market is the carbon buying/selling market implemented according to greenhouse gas reduction commitments when participating in the United Nations Framework Convention on Climate Change of countries. This market is mandatory and is mainly used in projects under the Clean Development Mechanism (CDM); Sustainable Development Mechanism (SDM) or Joint Implementation (JI); (2) Voluntary carbon credit trading market - is a market based on cooperation between countries, organizations or companies through bilateral or multilateral agreements. In this market, parties in need of credits will participate in buying and selling transactions on a voluntary basis to meet environmental, social and governance (ESG) policies in development towards reducing greenhouse gas emissions. The voluntary carbon credit trading market is a mechanism that encourages businesses to trade with each other to reduce carbon emissions. The market operates through regulations limiting the amount of emissions allowed to be emitted and allowing businesses to participate in trading emissions that have been reduced compared to the allowed limit. Through these transactions, a self-regulating mechanism will be formed, thereby restoring the carbon balance through reducing greenhouse gas emissions.

In Vietnam, environmental protection is identified by the Party and State as one of the three pillars for the country to develop rapidly and sustainably. The 13th National Party Congress continued to affirm: "... taking the protection of the living environment and people's health as the top goal; resolutely eliminating projects that cause environmental pollution, ensuring the quality of the living environment, protecting biodiversity and ecosystems; building a green economy, a circular economy, and being environmentally friendly" (Communist Party of Vietnam, 2021). According to the Law on Environmental Protection 2020, carbon credits are tradable certificates that represent the right to emit one ton of CO_2 or one ton of CO_2 equivalent. The domestic carbon market includes activities of exchanging greenhouse gas emission quotas and carbon credits obtained from domestic and international carbon credit exchange and offset mechanisms in accordance with the provisions of law and international treaties to which Vietnam is a member. Next, Decree No. 06/2022/ND-CP, dated January 7, 2022, of the Government, "Regulations on greenhouse gas emission mitigation and ozone layer protection" was issued. According to Decree No. 06/2022/ND-CP, from now until the end of 2027, the Vietnamese Government will focus on developing regulations on carbon credit management, greenhouse gas emission quota exchange activities and carbon credits; developing regulations on the operation of the carbon credit trading floor; Pilot implementation of carbon credit exchange and offset mechanisms in potential sectors and guidance on implementation of domestic and international carbon credit exchange and offset mechanisms in accordance with the provisions of law and international treaties to which Vietnam is a member; establish and organize the pilot operation of a carbon credit trading floor from 2025; implement capacity building activities and raise awareness of carbon market development; officially operate a carbon credit trading floor; from 2028, regulations will be issued on activities connecting and exchanging domestic carbon credits with regional and global carbon markets.

As a country with a large forest cover, Vietnam has great potential to develop forest carbon credit projects. In 2021, Vietnam had 612 million tons of carbon stored in forests, of which 80% came from natural forests. In the period 2010 - 2020, the emission reduction of the forestry sector mainly came from emission reduction activities from natural forest degradation, emission reduction activities from natural forest loss, and emissions from converting natural forests to planted forests. Regarding carbon absorption activities in the same period 2010 - 2020, the absorption was mainly due to natural forest restoration activities, afforestation including new afforestation and reforestation (Thuy et al., 2022).

Therefore, the issue of building forest carbon for green development in Vietnam needs to be thoroughly and scientifically researched to clarify the contribution of this type to green development in Vietnam today. This is an important basis for us to find a direction for building and developing the carbon market.

2. Methods

Analytical and synthetic methods: We conduct a survey and analyze the viewpoints of the Communist Party of Vietnam, policies and legal regulations of the Vietnamese Government related to the carbon market in general and the forest carbon market in particular.

Classification and systematization method: We classify documents, articles, and research works related to the construction and development of forest carbon markets for green development in

Vietnam today. From there, we systematize the works of practical experts related to the survey of forest potential in Vietnam.

Inductive and deductive method: Based on a systematic study of the contents and documents on the development of forest carbon markets for green development in Vietnam, we present the potentials, but at the same time point out the challenges that may be encountered. Thereby, we propose solutions to develop the carbon market in Vietnam today.

3. Results

3.1. Policies related to forest carbon management in Vietnam

Vietnam is one of the few countries in the Asian region with a clear legal corridor recognizing the role of forest carbon in adapting to and mitigating climate change as well as a clear orientation on forest carbon trading. In general, Vietnam's policies focus on establishing three general principles in operating the forest carbon market: (1) Regulating forest carbon sequestration and storage services through reducing greenhouse gas emissions, sustainable forest management, and green growth as a type of forest environmental service; (2) Regulating the responsibilities and obligations of all sectors and fields in implementing greenhouse gas inventories and greenhouse gas emission reduction measures for sectors and fields; (3) Determining the principles of operating the domestic market based on the roadmap for each stage and exploiting financial resources from carbon sequestration services, reducing greenhouse gas emissions for state-owned forest areas in accordance with the provisions of the Law on Management and Use of Public Assets. Specifically, these are:

Table 1: Policies related to forest carbon development in Vietnam

Year	Policy name	Regulations related to forest carbon
2015	Civil Code 2015 (National Assembly of Vietnam 2015)	Clause 1, Article 105, stipulates assets. With the regulation that forest carbon in the form of certified carbon credits can be considered one of the forest assets such as timber and non-timber forest products.
2017	Forestry Law No. 16/2017/QH14 was promulgated by the National Assembly on November 15, 2017, effective from January 1, 2019 (National Assembly of Vietnam 2017)	Provide a legal framework on forest ownership, financial mechanisms and benefit sharing for payments of forest environmental services, including contents related to forest carbon payments in Articles 2, 7, 61, 73.
2017	Decision No. 419/QD-TTg (Prime Minister of Vietnam 2017) issued on April 5, 2017 approving the National REDD+ Action Program to 2030	The aim of the programme is to access results-based payment sources in line with international requirements, etc. including revenue from forest carbon credit trading.
2017	Law on management and use of public assets (National Assembly of Vietnam 2017)	Regulations on state management of public assets, including types of resources.
2018	Decree No. 156/2018/ND-CP	Articles 64 to 75 stipulate contents related to management and use of forest environmental service fees.
2020	Law on Environmental Protection.	This Law clearly states the organization and development of the carbon market as an economic tool to promote the reduction of domestic greenhouse gas emissions, contributing to the implementation of the mitigation contribution committed by Vietnam when participating in the Paris Agreement on climate change.
2022	Decree No. 06/2022/ND-CP on greenhouse gas emission reduction and ozone layer protection	Some regulations related to forest carbon include Articles 3, 5, 8, 9, 16.
2022	Decree 08/2022/ND-CP (Government of Vietnam 2022c)	Regulations on payment for natural ecosystem services (Section I, Chapter X).

Year	Policy name	Regulations related to forest carbon
2022	Decision No. 01/2022/QD-TTg dated January 18, 2022 of the Prime Minister	Decision to promulgate the list of sectors and facilities emitting greenhouse gases that must conduct greenhouse gas inventories.
2022	National Strategy on Climate Change to 2050	Greenhouse gas emission reduction target.
2022	Decree 107/2022/ND-CP on Piloting the transfer of emission reduction results and financial management of greenhouse gas emission reduction payment agreements in the North Central region	The representative of the Ministry of Agriculture and Rural Development represents Vietnam to sign the agreement on the transfer of emission reduction results; regulations on revenue sources; implementation costs, etc.
2024	Directive No. 13/CT-TTg, dated May 2, 2024, On strengthening carbon credit management to implement nationally determined contributions	Strengthening carbon credit management to promote carbon market development; providing accurate and complete information on the carbon market; methods of creating carbon credits for trading on the market.

Source: Author's synthesis

3.2. Potential practical conditions for developing forest carbon markets in Vietnam

According to the documents we have researched and collected, currently, Tay Nguyen is a region with high forest carbon reserves and in addition, the Northeast, North Central and Central Coast regions all have the potential to develop and benefit from the forest carbon market. Particularly for forest carbon projects from new planting and reforestation activities, the potential area is mainly in the Northern region and there is only a small potential area in the Southern region. Calculating forest carbon reserves in different forest types and in localities from North to South has been studied by many Vietnamese scientists over the past two decades. These studies have shown that forest carbon reserves increase gradually with the age of the forest and in some places, mixed plantations have higher carbon reserves than monoculture plantations. According to the research results published by author Pham Ngoc Bay, in the period of 2005 and 2010, the area with low and medium carbon reserves accounted for the largest proportion but has tended to increase in recent years while the area with high carbon reserves has tended to decrease due to deforestation and forest degradation pressure (Bay, 2015). In addition, the Central Highlands and the South Central Coast are places with high forest carbon reserves. This is further evidenced by the statistics of the Ministry of Agriculture and Rural Development through Decision No. 2860/QD-BNN TCLN dated July 27, 2022 on announcing the national forest status in 2021 (Table 2).

In addition, Vietnam has also recognized the important role of land use, land use change and forestry in mitigating climate change and has increased its commitment to reduce emissions in this sector. Vietnam has also implemented many policy programs to reduce emissions from afforestation activities and improve forest quality, thereby reducing 11.1MtCO_2eq in 2021. According to policy makers of the consulting research group in Vietnam, the forestry sector has great potential to participate in the carbon market because it is the only sector with net emissions reaching the level. In 2021, Vietnam had 612 million tons of carbon stored in forests, of which 80% came from natural forests. During the period 2010 - 2020, the forestry sector emitted about 30.5 million tCO_2e annually and absorbed -69.8 million tCO_2e annually. Average annual emissions from the forestry sector decreased from 55.4MtCO_2e in 1995 - 2000 to 30.6MtCO_2e in 2010 - 2020 while average annual removals increased from -44.5MtCO_2e in 1995-2000 to -69.9MtCO_2e in 2010-2020. The forestry sector was also the only sector to achieve average annual net emissions in 2010 - 2020 at -39.3MtCO2e (Phuong, 2022).

According to the Forest Planning and Investigation Institute (2020), in the period 2010 - 2020, the amount of emission reduction in the forestry sector mainly came from emission reduction activities from natural forest degradation (18.315 million tCO_2e/year), emission reduction activities from natural forest loss (11.213 million tCO_2e/year), and emissions from converting natural forests to planted forests (4.737 million tCO_2e/year) (Thuy et al., 2022).

Table 2: Forest area development data in Vietnam in 2021

Region	Total forest area (ha)	Natural forest area (ha)	Forest area (ha)	Forest cover ratio (%)	GPT amount/net HT increase (million tCO_2e/ year) period 2010 - 2020
Nationwide	**14.745.201**	**10.171.757**	**4.573.444**	**42,02**	**59,661**
1. Northwest	1.808.285	1.584.974	223.310	47,06	5,988
2. Northeast	3.970.714	2.331.602	1.639.112	56,34	21,514
3. Red River Delta	83.326	46.326	37.000	6,18	0,816
4. North Central Coast	3.131.061	2.201.435	929.625	57,35	11,676
5. Coastal	2.451.496	1.566.677	884.820	50,43	14,998
6. Central Highlands	2.572.701	2.104.097	468.604	45,94	2,089
7. Southeast	479.871	257.304	222.566	19,42	2,428
8. Southwest	247.748	79.341	168.407	5,44	0,15

Source: Ministry of Agriculture and Rural Development (2022)

3.3. Challenges in developing forest carbon markets for green development in Vietnam currently

Firstly, although there are initial conditions for developing a forest carbon market, Vietnam is still facing many challenges in realizing its vision, strategy and current policies on this issue due to the limited knowledge and understanding of stakeholders about the forest carbon market while legal regulations and administrative procedures are still in the initial and pilot stages.

Secondly, pressures on forests and pressure to convert forests to socio-economic development purposes are still high while there are no attractive financial incentive mechanisms to encourage people to plant forests and provide forest carbon services.

Thirdly, scientific studies that comprehensively calculate costs and benefits for stakeholders are lacking, leading to difficulties in determining appropriate and fair selling prices. Fourth, the world is moving towards a high-value carbon market (carbon credits that are accurately verified, complementary and long-term, and are implemented to achieve both emission reduction, biodiversity conservation and enhancement, and positive social impacts for local communities and ethnic minorities). However, current policies in Vietnam only focus on increasing forest area and carbon stocks without taking into account the other two factors (biodiversity and social security measures).

3.4. Solutions to develop forest carbon market to serve green development in Vietnam

Firstly, urgently complete the policy mechanism to prepare for the development of the carbon market in general and the forest carbon market in particular in Vietnam. Although we now have the premise of legal corridors related to forest carbon, Vietnam still needs to continue to complete existing policies including sustainable forest management policies, support the expansion of forest areas with sustainable forest management certificates, expand the area of large timber plantations, build safety measures, clarify carbon rights, including carbon ownership rights, transfer rights, carbon credit trading rights, forest carbon benefit rights as well as responsibilities for each of these rights.

Second, gradually build and perfect the market operation and management mechanism, including carbon credit trading floors to unify state management work. Build a national registration system to manage the amount of carbon credits, along with connecting with systems and organizations participating in the market around the world. From there, connect with carbon market participants in which the subjects assigned to directly manage forest carbon will register for themselves trading accounts, providing information on the types and quantities of goods in need of trading when participating in the market. In addition, state management agencies need to identify competitive advantages, calculate towards the high-value forest carbon market segment - a trend that global businesses and buyers are aiming for and looking for. To achieve this goal, it is necessary to consider which forest areas should be prioritized, and to focus support policies towards improving forest quality and areas facing threats of deforestation/degradation; locations with biodiversity conservation value and positive impacts on local communities.

Third, improving the capacity and awareness of stakeholders and prioritizing support for small and medium enterprises, communities and ethnic minorities in forest implementation and development - a prerequisite for developing the forest carbon market. As presented above, the capacity, understanding and awareness of stakeholders in the forest carbon sector. In reality, the capacity, understanding and awareness of stakeholders in the forest carbon sector are still limited. Therefore, the need to improve the capacity of both buyers, sellers and local communities is an important condition to ensure the efficiency, effectiveness and fairness of the market. With limited resources, the Government and stakeholders should prioritize supporting small and medium enterprises and local communities in providing forest environmental services - these are those with limited financial resources, instead of spreading it to all forest subjects.

Fourth, continue to strictly implement the country’s emission reduction commitments, ensuring the competitive advantage of domestic enterprises. The implementation of commitments must be considered a prerequisite in developing the carbon market. Although many buyers have sought out Vietnam's forest carbon market and many provinces and cities want to sell forest carbon. However, in our opinion, it is necessary to prioritize ensuring that Vietnam fulfills its emission reduction commitment before selling these forest carbon credits to the international market. In addition, in the context of emission reduction becoming a mandatory trend globally, key enterprises and economic sectors of every country, including Vietnam, are required to ensure emission reduction commitments as a condition for being licensed to operate and conduct trade. Therefore, considering priority factors for domestic enterprises, ensuring that they own forest carbon credits to create a competitive advantage should be carefully considered. Furthermore, to operate the carbon market, state management agencies need to soon issue emission reduction contribution quotas for each industry and sector.

4. Conclusion

From the above analysis, it can be seen that the demand for carbon credit trading in the world, including the forest carbon market, has become urgent since the Kyoto Protocol with the establishment of a mandatory carbon market and a voluntary carbon market. In particular, currently, in the trend of global climate change and with the strong activities of the world community to minimize negative impacts, the development of the forest carbon market is considered a fundamental factor in the operation of the carbon market in the world as well as the domestic carbon market. The development of the forest carbon market will contribute to bringing about certain achievements not only in the goal of reducing greenhouse gas emissions but also taking advantage of financial opportunities for economic development to serve the goal of environmental protection and sustainable development. Therefore, it is necessary to continue to research and clarify issues related to feasibility, related legal policies and communities, etc. to develop the forest carbon market as a spearhead of economic development in the coming time, serving the goal of developing a green market in Vietnam.

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Research on Building the Carbon Market to Achieve Vietnam's Green Growth Goal by 2030

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Abstract

Despite the establishment of a carbon market being recognized as a crucial step towards achieving green growth by 2030 and Net Zero emissions by 2050, Vietnam's legal framework for such a market remains incomplete. This study aims to systematically examine international experiences with carbon markets and propose recommendations tailored to Vietnam's specific conditions. By analyzing reputable social science research from 2000 to 2023, the study identifies commonalities among countries with successful carbon markets. Additionally, a survey of 179 students and in-depth interviews with 6 experienced experts were conducted. The aim was to perform qualitative analysis, deeply analyze the perspectives of the experts, and understand the perceptions of a group of students, identifying the bottlenecks that need to be addressed. The findings highlight the experts' positive view of carbon markets as a flexible and effective tool for reducing greenhouse gas emissions (GHG). However, the study reveals that Vietnam's lack of a robust greenhouse gas measurement and inventory system has hindered the development of a domestic carbon market. While students demonstrate a general awareness of climate change and emissions reduction, their understanding of carbon markets is limited. This research contributes to policy recommendations for the Vietnamese government regarding the legal framework and public awareness. Future studies could benefit from expanding the survey to include businesses and increasing the sample size of students to enhance the comprehensiveness of the findings. The originality of this study lies in its comparative analysis of domestic and international conditions, as well as its exploration of student attitudes towards participation in the carbon market.

Keywords: *Carbon market, GHG, Net Zero, qualitative analysis, Vietnam*

1. Introduction

In 2023, European Centre for Medium-Range Weather Forecasts (ECMWF's 5th data) reported that the Earth broke its annual average temperature record - 1.48 degrees celsius, which was higher than pre-industrial levels and the planet is expected to surpass the 1.5-degree Celsius warming target set by the Paris Agreement (ECMWF, 2023) t. The 11% reduction in emissions from Nationally Determined Contributions (NDCs) is only half of the 20-25% decrease in carbon and other greenhouse gasses required to reach Net Zero by 2050 (IMF, 2023).

According to Country Environmental Analysis (CEA), due to the impacts of climate change, Vietnam lost $10 billion in 2020, equivalent to 3.2% of GDP (Worldbank, Vietnam Country Climate and Development Report, 2022). In order to prevent these negative impacts, as well as to pursue sustainable development, Vietnam is determined to set green growth as an economic objective by 2030. At the 2021 United Nations Climate Change Conference (COP 26, 2021), Vietnam also stated that the country aims to create a domestic carbon credit trading market and an exchange mechanism for offset carbon credits. As a result, it is vital to prepare and complete the legal framework while learning from international experience to develop a carbon market towards Vietnam's green growth target by 2030. The government is going to implement the program in 2025 and by 2028 it will be officially operated.

This paper explores the development of the world carbon market and serves as lessons for the Vietnam market. Furthermore, this study researches the actual conditions and difficulties in developing a carbon market in Vietnam along with the awareness of the barriers to stakeholders's market participation. Consequently, our paper proposes solutions to promote the operation of the Vietnam carbon market based on a growth target to 2030 in a 5-year period (2024-2028).

2. Literature review and Theoretical framework

2.1. Literature review

The development of cap and trade programs in several countries is indicated in Table 1.

Table 1: Cap and Trade programs in several countries

Region/Country	US		EU	Japan	Korea	China
Name	RGGI (2009)	California Cap-trade Program (2012)	EU-ETS (2005)	Tokyo ETS (2010)	K-ETS (2015)	ETS (2021)
Goal	Netzero	Netzero 2050	Netzero 2050	Netzero 2050	Netzero 2050	Netzero 2060
Legal framework & infrastructure	Completed	Completed	Well-completed with MRV	Completed	Completed	Well-completed with MRV
Sector	Electricity and heat	(i) Electricity and heat (ii) Industry (iii) Mining and extractives (iv) Transport (v) Building (vi) Agriculture, forestry, fishing fuel use	(i) Electricity and heat (ii) Industry (iii) Mining and extractives (iv) Aviation	(i) Electricity and heat (ii) Industry (iii) Mining and extractives (iv) Building	(i) Electricity and heat (ii) Industry (iii) Mining and extractives (iv) Transport (v) Aviation (vi) Building (vii) Waste	Electricity and heat
Cap	Tighter by years					
Revenue use	(i) Energy efficiency; (ii) Clean and renewable energy; (iii) Mitigation; (iv) Direct bill assistance (e.g. energy bill rebates)	(i) Transportation and sustainable communities; (ii) Clean energy and energy efficiency; (iii) Natural resources and waste diversion.	At least 50% of auctioning revenue for climate and energy related purposes: (i) Renewable energy (ii) Energy efficiency (iii) Sustainable transport (iv) R&D (v) Other domestic	...	Supporting: (i) Mitigation equipment; (ii) Low-carbon innovation; (iii) Technology development of covered entities.	...
Impacts	Encourage low-carbon innovation and investment Have a positive impact on economic, but still unclear whether or not it has reduced GHG emissions		Encourage low-carbon innovation and investment	Encourage low-carbon innovation and investment Reduced CO2 emissions by 6.9% annually	Encourage low-carbon innovation and investment	Realizing "2 carbon goals" towards green, sustainable development:(i) achieving carbon emissions (ii) being carbon neutral

Source: Compiled by the authors

In Vietnam, from 1986 to 2022, Vietnam has achieved remarkable economic growth within ASEAN, with a GDP of 406.45 billion USD in 2022, which is 50 times that of 1986 (Economic life Article, 2023). However, this development has also led to an increase in greenhouse gas emissions, due to dependence on resource extraction (brown economy). Forecasts indicate that without appropriate adaptation measures, climate change could cause Vietnam to lose about 12-14.5% of its GDP annually by 2050 and push up to one million people into extreme poverty by 2030 (Worldbank, Vietnam Country Climate and Development Report, 2022). Recognizing the potential negative impacts of climate change on the economy, society and environment which could hinder the momentum towards achieving Vietnam's SDGs, the government needs to change its economic development strategy towards green growth, achieving development goals and fulfilling climate commitments.

Vietnam has committed to lowering greenhouse gas emissions by signing the Kyoto Protocol by 2002 and the United Nations Framework Convention on Climate Change (UNFCCC) by 1994. Vietnam aims to reduce total greenhouse gas emissions by 15.8% from domestic resources compared to the Business as Usual (BAU) scenario during the 2021-2030 period, equivalent to 146.3 Mt CO2eq. Provided with international financing support, especially under UNFCCC and Paris Agreement, Viet Nam can increase its total emission reduction contribution to 43.5% by 2030 compared to BAU (UNFCCC, 2022).

The development of the domestic carbon market in Vietnam was first mentioned in the National Action Plan on Climate Change through Decision No. 1474/QĐ-TTg on October 5, 2012. The main objective of this plan is to reduce greenhouse gas emissions and develop a low-carbon economy. Although there have been many efforts and legal regulations related to carbon credit mechanisms, the domestic carbon market has not yet been fully established due to various reasons, including inadequate policy mechanisms, underdeveloped infrastructure, and a lack of expertise in carbon market development.

Vietnam has great potential in generating carbon credits, with the ability to reduce emissions from various sectors such as energy, agriculture, land use, and waste. Currently, this country has over 100 projects that have been granted carbon credits for international trade and ranks fifth globally in the number of carbon credits. Businesses and organizations across the country currently have about 41 million carbon credits, ranking fifth among countries generating carbon credits. Around the world, the growing demand for voluntary carbon credits is creating increasingly significant opportunities for revenue and investment in Vietnam. However, it is necessary to carefully consider the benefits of developing voluntary markets and mandatory carbon markets in a way that is advantageous for businesses and the domestic economy in the long run.

In November 2021, Vietnam officially entered the Net Zero race after committing to achieve NetZero emissions at COP 26 in Scotland. Vietnam set the goal of reducing greenhouse gas emission intensity across all sectors and greening its economic industries. The World Bank's 2022 CCDR report proposes two pathways for Vietnam to simultaneously achieve development goals and fulfill climate commitments: enhancing resilience to climate impacts and pursuing a growth strategy that gradually reduces carbon-intensive energy sources. The top priority is to enhance adaptability through investment solutions and energy transition, while minimizing carbon emissions (World Bank, 2022).

The establishment of a carbon market brings many practical benefits to the economy, including reducing greenhouse gases and promoting sustainable development. The social and environmental value of building this market is undeniable. Economically, the carbon market will benefit localities and enhance the competitiveness of business products. Revenue from the sale of carbon permits will become an important source of income for the government, helping them reinvest in renewable energy or support businesses through tax and fee reductions, encouraging production with cleaner technologies. In addition, it is necessary to take advantage of non-refundable aid and preferential conditions regarding capital, finance, and technology, along with the proactive participation of domestic enterprises and private investors to support businesses in transitioning to emission-reducing technologies.

Previous studies have shown the benefits and necessity of establishing a carbon market, especially an ETS (Cap and Trade program). Currently, the legal documents related to the establishment of the carbon market are being finalized urgently. The proposal to develop the carbon market in Vietnam from the Ministry of Finance is based on the regulations of the 2020 Environmental Protection Law, dividing the roadmap for building the market into 3 phases: (i) before 2025; (ii) from 2025 to 2027; and (iii) from 2028 to 2030.

In the process of researching and reviewing previous studies, we found that there is still a need for further in-depth research on the legal framework for building a carbon market. Therefore, our research paper aims to systematize the experiences of the Carbon market worldwide and based on the context of Vietnam's actual conditions, to propose solutions for the government, firms and stakeholders to be ready for joining in a pilot Carbon Market in 2025 while also surveying the readiness and awareness of the student group in regarding the development of the carbon market.

2.2. Theoretical framework

According to the definition of the United Nations, carbon markets are trading systems in which carbon credits are sold and bought. Companies or individuals can use carbon markets to compensate for their greenhouse gas emissions by purchasing carbon credits from entities that remove or reduce greenhouse gas emissions. One tradable carbon credit equals one tonne of carbon dioxide or the equivalent amount of a different greenhouse gas reduced, sequestered or avoided. When a credit is used to reduce, sequester, or avoid emissions, it becomes an offset and is no longer tradable (UNDP, 2022). The carbon market includes the compliance market and the voluntary carbon market.

This study is based on the main theories and conceptual frameworks regarding carbon markets and green growth, two central factors in the sustainable development process in Vietnam. (VNS, 2024) The carbon market is an important tool in fulfilling commitments to reduce greenhouse gas emissions, driven by international agreements such as the Kyoto Protocol and the Paris Agreement (UNFCCC, 2022). This market allows countries and businesses to trade carbon credits, aiming to optimize economic efficiency and minimize the impact of emissions on the environment.

The theory of green growth provides a foundation for economic development without increasing pressure on the environment. According to this theory, the transition to a green economy model will help mitigate the negative impacts of climate change by utilizing green technologies and improving production processes to minimize emissions. Green growth not only helps protect the environment but also promotes sustainable long-term economic activities.

Furthermore, the theory of sustainable development serves as the foundational framework for this research, with economic, social, and environmental factors harmoniously integrated. Sustainable development requires not only economic growth but also ensuring that natural resources are used wisely and efficiently to maintain the quality of life for future generations.

Finally, carbon pricing models and carbon credit trading are the tools that are being studied to assess the impact of emission reduction policies on the Vietnamese economy. This theoretical framework will help clearly identify the influencing factors and necessary conditions for Vietnam to successfully develop a carbon market, thereby aiming towards the goal of green growth and fulfilling international commitments on climate change.

3. Methods

3.1. Research procedures

The authors have developed a research process to understand the level of interest of target groups in society in the Vietnamese carbon market. The process includes the steps of:

Desk research: Secondary data collection and analysis to assess the state of the carbon market.

Qualitative research: In-depth interviews with 6 experts to gather opinions and orientations for the proposal phase. Survey of 179 students from 25 universities in Hanoi.

Based on the results, the group makes proposals for Vietnam's carbon market towards the 2030 green growth goal.

3.2. Desk research

Purpose: Learn information from secondary data to evaluate overviews and identify research gaps.

Methodology: Use internal and external data sources, primarily from reputable documents, government reports, and previous research.

Research results: The group analyzed and drew on international experience to apply to building the carbon market in Vietnam.

The group of authors conducted preliminary research on the carbon market in the United States, focusing on changes in operational mechanisms, attitudes of leaders, and particularly the legal framework through several programs such as the Acid Rain Program (1990), the Regional Greenhouse Gas Initiative (RGGI), and California. The Acid Rain program has been positively evaluated and laid the groundwork for subsequent programs by establishing specific limits for each phase, helping to reduce costs and transaction time. In the early stages of the program, this market sets a specific ceiling. In the two implementation phases, the program applies only to the electricity sector, with an operational mechanism similar to today's ETS market, by determining the total amount of emissions and setting quotas based on the basic heat input of power generation units.

After that, the authors explored the European region through the EU-ETS market, which is considered the most comprehensive CO2 emissions system in the world. This market is also starting to pilot in the electricity and energy sector. Although the initial lack of data led to the limitation of emissions exceeding estimates, after adjustments, the free quotas gradually decreased, and the market operated under a quota auction mechanism.

Finally, the research team examined the carbon market in the Asia region, particularly in Japan and South Korea, while also exploring the overall context of Vietnam. Research emphasizes the importance of monitoring systems, data collection, and transparency. Vietnam can flexibly apply and learn from the operational mechanisms of the EU-ETS, Tokyo ETS, and California cap and trade program for the upcoming domestic market.

3.3. Qualitative research

Interview with experts: The group interviewed 6 carbon market experts to collect opinions and evaluate the situation in Vietnam.

Student survey: The survey subjects were students aged 18-22 years. The aim was to test students' perceptions of greenhouse gas emissions and the carbon market.

A total of 179 survey votes were obtained, after eliminating 50 invalid votes, leaving 129 votes enough for analysis.

4. Results

4.1. Expert evaluation result

The overall carbon market

The carbon market is seen as a crucial instrument for controlling the actions of involved parties. There are two basic categories of markets: obligatory and voluntary. It functions according to the principles of value, supply, and demand. This market has procedures akin to financial or commodity markets, in addition to reflecting political decisions.

Businesses engaging in the carbon market need to assess the marginal abatement cost when selecting green technologies, resulting in excess allowances that can be exchanged. The carbon market is managed by three ministries: The Ministry of Natural Resources and Environment, the Ministry of Industry and Trade, and the Ministry of Finance, with the expectation that the Ministry of Finance will take responsibility to operate the trading floor. The operating technique shares many parallels with the stock exchange and involves a wide range of business kinds from various sectors. However, a clear allocation of responsibility among the parties has yet to be determined.

Features of various market types and the benefits of the carbon market

Compared to carbon taxes or other carbon pricing mechanisms, the carbon credit trading market functions efficiently in many countries because it is founded on the concepts of cap-and-trade, quotas, and trading. These principles offer this type of instrument efficiency and flexibility. Vietnam is among the nations that do not require carbon tax instruments or carbon credit trading platforms. Meanwhile the carbon tax is set and imposed on products like gasoline and oil, and this indirect taxation can easily trigger public response when the government raises taxes, the carbon market adjusts the price flexibly according to the laws of supply and demand.

Vietnam has implemented a voluntary carbon market, but it should improve the current legal system and incentive mechanisms to actively participate in this market. Our country has implemented about 150 projects to reduce emissions and sell forest credits internationally. With the great potential from forest areas and renewable energy sources, the carbon market can contribute to sustainable development goals and mitigate the impacts of climate change.

Experts assess that the development of the carbon market is necessary and appropriate, aiming to encourage businesses to participate in reducing greenhouse gas emissions in an economical and effective manner. Early participation in the market will help businesses transition to new technologies and reduce emissions costs.

Opportunities and challenges for Vietnam's carbon market

Vietnam is considered to have a great deal of untapped potential because of its capacity to increase corporate carbon reductions and investments in forestry and agriculture. Currently, the country has about 41 million carbon credits, ranking fifth among countries generating carbon credits. Businesses have a variety of methods to reduce emissions: changing inputs, developing renewable energy systems, and improving management processes and technology can also help reduce greenhouse gasses more effectively.

However, Vietnam also faces some challenges such as obstacles in legal framework development, difficulties in measuring and reporting greenhouse gasses, and the issue of carbon credit pricing. The state must carefully protect property rights regarding quotas and carbon credits, ensuring transparency and legal protection. Another issue is that the MRV system, especially the verification, must be accurate. Additionally, despite the fact that an increasing number of firms are becoming engaged in environmental issues, there is still a lack of community understanding regarding the carbon market. Vietnam needs expert assistance to address these obstacles, as well as measures to manage carbon credits, enhance the legal framework, and raise public awareness of this market.

Vietnam's carbon market incentive mechanism

Experts who were asked about ways to help the government and state overcome obstacles and get ready for the construction of the market and the involvement of stakeholders in Vietnam all agreed that expediting the completion of the legal framework and greenhouse gas inventory is essential to having specific data for the emission reduction plan. For the carbon credit market to function efficiently, credit exchange transparency is thought to be of utmost importance.

Businesses are aware of the carbon market, but they need support from the government through workshops and training sessions to fully understand how it operates. In addition, the government should also provide incentives and support for the technical infrastructure and technology for green production models and the use of renewable energy.

The Vietnam carbon market's goals

The carbon market is viewed as an adaptable and effective economic instrument that influences several government goals, although sustainable development is the ultimate purpose. Vietnam's current overarching strategy aims to build its society and economy through sustainable development methods, with an emphasis on both promoting carbon reductions and economic growth. The adoption of the carbon market mechanism is expected to have a substantial impact on the shift in society toward the reduction of greenhouse gas emissions and the attainment of the Net Zero 2050 objective.

The role of education

Experts believe that integrating carbon market knowledge into teaching is important, but it will take time to update once the market is operational. Knowledge in this field is not only limited in Vietnam but also in countries that have developed carbon markets like the United States.

Despite being a recent and important topic, there is currently no specialist subject on the carbon market in Vietnam's educational curriculum. For the time being, students must actively look for and participate in carbon market-related learning opportunities because they will eventually need to be knowledgeable about climate policy. Training programs and workshops, business cases should be given by educational institutions.

4.2. Student survey result

In 129 survey samples, 60.5% of the respondents chose motorcycles as the main means of transportation; 22.2% of the students walk, 14% of them use public transportation and the rest use other means.

The reason for not using public transportation (buses, bicycles, trains, etc.), 86 surveys said that the bus routes were not convenient when traveling and 80 surveys show that the use of public transportation takes more time than private transportation. Other reasons are the lack of proximity to bus stations, poor service attitude, prohibitive cost and lack of priority lanes.

In 129 students surveyed, 62.8% were aware of Vietnam's commitment to Net Zero by 2050. From there, it partly shows that students' awareness of reducing greenhouse gas emissions in our country is relatively great when the proportion accounts for more than 1/2 of the total number of students surveyed. However, only 39.5% know about the time when the carbon credit market will be piloted in Vietnam in 2025. This is quite understandable when the carbon market is still a very new environment for our country, so for those who are not directly subjected to the carbon credit market, it is necessary to understand the pilot implementation.

Approximately, 92.2% of the students are willing to accept the introduction of the carbon market into teaching, showing a desire to develop green development and reduce greenhouse gasses.

Generally, regulation about Vietnam's commitment to reduce greenhouse gas emissions at COP-26, Decree 06/2022/ND-CP: Regulations on reducing greenhouse gas emissions and protecting the ozone layer, only about 60%-80% of students participating in the survey had answers that they had almost heard but did not understand. In which, about 17% of environmental students participating in the survey also have a vague understanding of the above information. Students who understand the above information significantly account for about 20% - 30%.

5. Discussion and Conclusion

The research was conducted to develop a carbon market aimed at green growth by 2030. The carbon credit market is a market-based economic tool that has the ability to adjust the market in a flexible and adaptable manner. The carbon market has proven its benefits in reducing emissions, creating incentives for transition, and contributing to achieving multiple goals. As mentioned above, this is a market-based economic tool, so the market must be transparent in order to operate effectively. The main solutions include: it is necessary to identify specific sectors/fields that have high emissions and potential for the MRV system in the future, and to develop a national carbon credit exchange using technologies such as Blockchain to ensure transparency.

The basic conditions regarding infrastructure, a clear legal framework, along with specific guidelines on the use and valuation of carbon credits as well as mandatory emissions measurement need to be established. The government, businesses, and consumers play a crucial role in building the carbon market; the government needs to establish supportive policies, while businesses must manage emissions and invest in emission-reducing technologies. In addition, research and development policies should encourage collaboration between the public and private sectors to foster innovation and reduce emissions. To equip students with relevant knowledge and skills, the government, schools, and businesses should organize workshops and training programs. Building a carbon market in Vietnam will require close cooperation among all stakeholders to ensure success in addressing climate change and moving towards sustainable development.

Most importantly, the authors would like to emphasize that ensuring transparency and fairness is a prerequisite for the effective functioning of this economic tool; however, it has not yet been perfected. Until this challenge is resolved, the effectiveness of the tool will be limited, much like a car missing a gear. We need to strengthen research, establish a strict monitoring mechanism, and enhance community participation to ensure the fairness and transparency of the tools, thereby creating sustainable development.

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A Legal Analysis of Carbon Tax Implementation in Vietnam and Taiwan: Comparative Approaches and Policy Recommendations

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Abstract

This paper analyzes two main approaches to carbon tax implementation: the fuel-based approach and the direct emissions approach. Data from both countries' greenhouse gas emissions from key sectors such as energy, industry, and agriculture are utilized. The research methodology includes a comparative analysis of existing carbon tax policies globally, particularly in developed nations, and assesses their applicability in the context of Vietnam and Taiwan. The results indicate that the fuel-based approach offers a more practical short-term solution due to lower administrative costs and ease of implementation, while the direct emissions approach is more suitable for long-term application as the MRV (Measurement, Reporting, and Verification) systems in both countries mature. The study concludes that a phased transition from a fuel-based to a direct emissions approach will provide an effective economic tool for reducing greenhouse gas emissions and achieving sustainable development goals.

Keywords: *Sustainable development, Net-zero, carbon tax, direct emissions approach, fuel-based approach, greenhouse gas emissions*

1. Introduction

Climate change and global warming, driven by increasing greenhouse gas (GHG) emissions, have become critical global challenges. Vietnam and Taiwan face significant environmental and economic pressures to reduce their carbon emissions and contribute to the international goal of achieving carbon neutrality by 2050. Carbon tax, as one of the most effective tools for mitigating GHG emissions, has been successfully implemented in several countries. However, Vietnam and Taiwan have yet to adopt this policy, highlighting the need to explore suitable carbon tax approaches for these economies. The importance of this research lies in analyzing how a carbon tax can be designed to suit the specific economic, environmental, and administrative contexts of both nations.

This paper aims to analyze the current state of GHG emissions in Vietnam and Taiwan; compare the effectiveness of the fuel-based and direct emissions approaches to carbon tax; propose an optimal approach for carbon tax implementation in Vietnam and Taiwan, considering their goals of achieving carbon neutrality by 2050; and highlight potential challenges and provide policy recommendations for a phased transition from a fuel-based approach to a direct emissions approach.

Previous studies on carbon tax primarily focus on developed economies with well-established environmental regulations and infrastructure. Countries such as Sweden, Japan, and the UK have successfully implemented carbon taxes, showing a significant reduction in carbon emissions. However, there is a research gap in the application of carbon tax in developing or rapidly industrializing economies like Vietnam and Taiwan. Few studies address the unique challenges these countries face, such as limited infrastructure for measurement, reporting, and verification (MRV), and their reliance on fossil fuels for energy production. This research aims to fill this gap by providing tailored recommendations for Vietnam and Taiwan based on their specific conditions.

This research is grounded in environmental economics and policy theory, focusing on the role of market-based mechanisms such as carbon tax in addressing negative externalities like GHG emissions. The analysis draws upon the principles of the "polluter pays" model and carbon pricing strategies used in various global contexts. Additionally, the study examines the feasibility of different carbon tax approaches, particularly the fuel-based and direct emissions approaches, in the context of Vietnam and Taiwan’s socio-economic and industrial landscapes.

2. Methods

This study employs a comparative legal and economic analysis to explore the potential for carbon tax implementation in Vietnam and Taiwan. The methodology consists of several key components:

Comparative approach: The research compares two main carbon tax models—fuel-based and direct emissions analyzing their application in different international contexts, particularly in developed nations such as Sweden, Japan, and the UK. The comparison focuses on understanding the administrative, economic, and environmental implications of each model for Vietnam and Taiwan, two rapidly industrializing economies.

Data collection: Data was collected from official sources on greenhouse gas (GHG) emissions in Vietnam and Taiwan, including energy, industrial processes, and waste management sectors. Additionally, existing carbon tax policies in other jurisdictions were analyzed to assess their relevance and applicability.

Legal framework analysis: The study critically evaluates the current environmental laws and policies in Vietnam and Taiwan, particularly focusing on legislation related to GHG emissions, such as Vietnam's Law on Environmental Protection and Taiwan's Greenhouse Gas Reduction and Management Act. This analysis identifies the legal gaps and challenges that must be addressed for effective carbon tax implementation.

Policy feasibility assessment: The feasibility of the fuel-based and direct emissions approaches is assessed based on factors such as administrative complexity, cost, and the maturity of the Measurement, Reporting, and Verification (MRV) systems in both countries. This assessment includes an analysis of how these models could be phased in, with particular attention to the socio-economic and industrial contexts of Vietnam and Taiwan.

Recommendations: Based on the comparative and feasibility analysis, the study offers tailored policy recommendations for the phased implementation of a carbon tax in Vietnam and Taiwan. This includes an initial focus on the fuel-based approach, followed by a gradual transition to the direct emissions approach as MRV systems mature.

This approach ensures that the carbon tax is aligned with each country's long-term goals of achieving carbon neutrality by 2050, while also addressing the unique economic and environmental challenges faced by both Vietnam and Taiwan.

3. Results

The analysis indicates that both Vietnam and Taiwan have the potential to adopt a carbon tax as a viable economic instrument for reducing greenhouse gas (GHG) emissions and achieving net-zero targets by 2050. In the short term, a fuel-based carbon tax emerges as the most feasible solution for both Vietnam and Taiwan. This approach is practical due to its immediate applicability and low administrative costs, making it especially suitable for imported fuels, which play a significant role in Taiwan's energy landscape. By focusing on fossil fuel consumption, a major source of emissions in both economies, the fuel-based approach allows for efficient emission management in the near term.

In contrast, the direct emissions-based approach presents more long-term benefits, particularly as the Measurement, Reporting, and Verification (MRV) systems in both Vietnam and Taiwan advance. While this method requires considerable investment in emissions measurement infrastructure, it offers a more comprehensive solution for controlling emissions from large industrial facilities. As both economies develop more sophisticated emissions tracking and reporting systems, a gradual transition toward combining fuel-based and direct emissions approaches is expected, allowing for more effective and comprehensive emissions management strategies in the future.

3.1. Current greenhouse gas emissions in Vietnam and Taiwan

Greenhouse gases (GHGs) are one of the main causes of global warming and climate change. Currently, in Vietnam, GHGs are primarily emitted from the combustion of fuels for the energy sector and industrial activities. The increasing amount of GHG emissions is both a global issue and a specific challenge for individual countries, requiring attention to reducing GHG emissions. During the period from 2000 to 2014, Vietnam's total GHG emissions increased from 150.90 million tons of CO_2e to 283.97 million tons of CO_2e in 2014 (an increase of 1.88 times) (Nguyen & Nguyen, 2021). By 2016, Vietnam's total net GHG emissions for that year were approximately 316.736 million tons of CO_2e, of which GHG emissions from the energy sector accounted for 205.832,20 thousand tons of CO_2e, making up the largest share at 65%. This was followed by industrial processes and product use, contributing 46.094,64 thousand tons of CO2e, or 14.6%. The net emissions from the agriculture, forestry, and land use sectors were 44.069,74 thousand tons of CO2e, with CO_2 absorption from land at -39.491,24 thousand tons of CO_2e, accounting for the third-largest share at 13.9%. The smallest contributor was the waste sector, with 20.738,38 thousand tons of CO_2e, accounting for 6.5% (Ministry of Natural Resources and Environment, 2020).

In Taiwan, the Environmental Protection Administration publicly released the "National Greenhouse Gas Inventory of the Republic of China (Taiwan) for 2024" on June 25 through the "Climate Information Center". The statistical results indicate that in 2022, Taiwan's total greenhouse gas emissions reached 285.97 million tons of carbon dioxide equivalent ($MtCO_2e$), with carbon sinks offsetting 21.83 $MtCO_2e$, resulting in net emissions of 264.13 $MtCO_2e$. This represents a 4.07% reduction compared to 2021 and a 1.77% reduction compared to the base year of 2005 (Ministry of Environment, 2024).

Both Vietnam and Taiwan have not yet directly implemented a carbon tax, but both governments have plans to promote the implementation of a carbon tax or an emissions trading system (ETS) in the near future.

In Vietnam, Clause 2 of Article 90 of the Law on Environmental Protection (2020) stipulates the organization and implementation of activities to reduce greenhouse gas emissions (GHG) and absorb GHG in accordance with a roadmap and methods that are suitable for the country's conditions and international commitments. Additionally, Government Decree No. 06/2022/ND-CP, dated January 7, 2022, provides guidance on the organization and development of a domestic carbon market. It lays out a roadmap to establish a pilot carbon market by 2025 and an official market by 2028. The pilot phase focuses on developing regulations and mechanisms to operate the market, implementing capacity-building activities, and establishing and running pilot markets in potential sectors. It can be seen that the current environmental protection law has introduced the carbon market as a policy tool. Accordingly, on September 29, 2023, the ASEAN Carbon Credit Exchange Joint Stock Company officially launched, becoming the first Vietnamese enterprise to initiate a carbon credit exchange platform.

In Taiwan, the Greenhouse Gas Reduction and Management Act (2015) serves as the primary legal framework for establishing measures to reduce greenhouse gas emissions and achieve the goal of carbon neutrality by 2050. This Act not only sets specific emission reduction targets but also paves the way for the implementation of a carbon tax and other carbon pricing mechanisms, including ETS. Article 16 of the Act stipulates that the government must establish greenhouse gas management systems, which include the measurement, reporting, and verification of emissions from major emitting facilities. This is a foundational step for implementing a carbon tax or an ETS.

Many studies have indicated that there are five types of policy tools: finance and economics, business, management and government, energy regulation, and finally, research and development. Among them, the carbon tax (also known as the fuel combustion tax) is recognized as one of the most important energy policy tools in the financial and economic sector to limit GHG emissions. As of 2024, according to the World Bank, 37 countries and regions have implemented a carbon tax, including the UK, France, Sweden, Norway, Finland, Japan, India, Singapore, etc (World Bank, n.d.). Considering the emission reduction direction and development mindset of Vietnam and Taiwan, along with the proven benefits of the carbon tax from over 30 years of global application, the authors believe that Vietnam and Taiwan should consider adopting a carbon tax to ensure the achievement of their carbon neutrality goals and to support the existing economic tools in both countries.

3.2. Approach to carbon tax

3.2.1. The fuel approach

The fuel-based approach is the dominant method of carbon tax worldwide (with the exception of Chile, Singapore, and South Africa, which use a direct emission approach). This approach involves taxing fossil fuels such as oil, natural gas, coal, and their derivatives, with the tax rate based on the carbon content of the fuel. The key feature of this approach is that the amount of carbon emissions is closely related to the carbon content of a specific type of fuel. Therefore, the emissions from burning fuel can be determined using standardized carbon emission factors (United Nations, 2021). Since this method takes a fuel-based perspective, countries will need to consider how much GHG emissions the fuel will produce when burned in order to estimate the emissions for that fuel. The advantage of this approach is that there is no need to measure the actual emissions of the fuel at the emission source. Thus, when designing a carbon tax, the tax rate can be expressed either by volume or weight (e.g., per liter of gasoline or per ton of coal) based on the average carbon content of each type of fuel.

The fuel-based approach requires a differentiated approach for each type of fuel. This is because each fuel emits different amounts of GHGs when burned. Therefore, under this approach, the tax will focus on specific fuels rather than the GHGs emitted during their consumption. The units used for fuel will be by volume or weight, making the calculation and determination of the carbon tax relatively simple. In practice, for administrative reasons, countries tend to group similar fuels into categories that share the same tax rate per liter or ton (United Nations, 2021). Although these fuels may have different qualities during production or importation, leading to different GHG emissions when burned, this can be addressed by allowing the government to determine the average emissions of these fuel types and set an appropriate value. This does not diminish the effectiveness of the carbon tax or the incentive to reduce emissions, as consumers will be encouraged to choose better technologies to save fuel, thereby achieving the purpose of the carbon tax. Additionally, producers or importers will need to adopt new technologies to produce fuels with lower carbon content, and importers will have to select fuels with lower carbon content to reduce the taxes they pay. Furthermore, the fuel-based approach has a wide scope of application, as any entity using goods that emit GHGs when burned will be subject to the carbon tax, which is a key feature of this approach.

Since the fuel-based approach is used, taxes can be imposed at any point from extraction or importation to consumption. However, in effect, taxes collected from producers, importers, or consumers yield the same result since the tax is added to the price of goods containing carbon content. Collecting taxes from producers or importers is simpler than collecting directly from consumers, as the number of producers or importers is smaller than that of consumers (University of Economics - Vietnam National University, 2022). Therefore, taxing producers or importers ensures cost efficiency and simplifies administrative procedures. Moreover, since the tax is already embedded in goods with carbon content, it eases the burden on taxpayers and reduces the negative impact of the carbon tax. Countries such as Sweden, Colombia, and Zimbabwe are examples of those that have implemented this method of tax collection for carbon taxes.

3.2.2. The direct emissions approach

The direct emissions approach is a method in which the carbon tax targets emissions that are directly released at the source, meaning the location where fuel is burned and GHGs are emitted directly into the environment, regardless of the fuel type or specific combustion process. The key advantage of this approach is that it can extend carbon tax to non-fuel emissions and other GHG emissions. However, to implement this method, a complex emissions measurement system at the source must be developed, along with an administrative system with relatively complex regulations on MRV to accurately determine the amount of GHG emissions released into the environment. Therefore, the cost associated with this approach is relatively high and can only be applied at large emission sources, such as large factories, power plants, and refineries, to ensure cost-effectiveness. This is a significant drawback of the direct emissions approach, which is why, currently, only Chile, Singapore, and South Africa have implemented this method globally.

When adopting the direct emissions approach, the tax target is GHG emissions, regardless of the fuel used. For instance, Chile's carbon tax focuses on emissions such as CO2, PM, NO_X, and SO_2

(International Monetary Fund, Fiscal Affairs Department, 2023). In Singapore, the carbon tax applies to emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) (Singapore Government, 2018). In South Africa, the carbon tax targets various fuels and natural gases, such as coal, oil, petroleum products, and natural gas, as outlined in Annex 01 of the 2019 Carbon Tax Act. The emissions factor for CO_2, CH_4, and N_2O is the focus of these taxes. However, a common feature of the carbon tax in all three countries is its limited scope: in Chile, the tax applies to large facilities such as boilers or turbines (International Monetary Fund, Fiscal Affairs Department, 2023); in Singapore, it is mandatory only for large industrial facilities emitting 25,000 tCO_2e or more per year (National Climate Change Secretariat Singapore, n.d.); and in South Africa, it applies to the electricity and industrial sectors (World Bank Group, n.d.). This shows that the direct emissions approach cannot be applied as widely as the fuel-based approach. Implementing this method requires a robust MRV system, necessitating close coordination between environmental and tax authorities to ensure accurate data for tax collection and GHG monitoring.

Additionally, the characteristics of this approach lead to a change in the taxpayer compared to the fuel-based approach, specifically targeting those who directly emit GHGs. As a result, the carbon tax does not need to be pre-determined for each type of fuel, but instead, the tax payment is based on emission data collected by the measurement system. This makes carbon tax fairer, as facilities that emit more will pay higher taxes and vice versa. This encourages emitting facilities to find effective methods to minimize emissions in order to reduce their tax burden. Moreover, since there is no carbon tax embedded in the fuel, the fuel itself becomes cheaper compared to the fuel-based approach.

4. Conclusion and Recommendations

By analyzing the two approaches to designing carbon tax policy, the authors recognize that both methods have certain advantages and disadvantages. Through the analysis and identification of these pros and cons, combined with the economic and social conditions and characteristics of Vietnam, the authors propose a suitable approach for Vietnam in selecting the most appropriate method.

Table 1: Advantages and disadvantages of the fuel-based approach and the emissions-based approach to carbon tax

Approach	Advantages	Disadvantages
The fuel-based approach	- The tax rate is clearly defined within the fuel; - Administratively simple and can be applied directly within the existing tax collection system without creating too many complex measurement and control procedures; - Broad scope of application for all entities using fuel, covering GHG emissions from large businesses to small facilities and transportation vehicles; - Reasonable tax collection costs.	- A careful and reasonable tax rate must be determined to ensure fairness in the application of the tax. - Focuses only on controlling CO_2 emissions or certain specific emissions. - Does not truly encourage the development of an MRV system; - In some cases, it does not create fairness in the application of the carbon tax; - May affect liquidity in business operations since the tax must be paid before the fuel is sold to consumers.
The direct emissions approach	- The tax is clearly determined based on the GHG emissions released into the environment; - Due to the high requirements for measurement, it will encourage the development of the MRV system; - It can control most GHG emissions by directly measuring them at the source; - Ensures fairness in tax collection for GHG emissions released into the environment.	- Requires the installation of a complex MRV system, which incurs high costs. Additionally, the MRV mechanism requires a complex administrative system to ensure fairness and accuracy in carbon tax collection; - High tax collection costs; - Difficult to apply to small facilities due to the large number of them and the high costs involved; - Cannot be applied to transportation fuels;

Approach	Advantages	Disadvantages
		- Requires close coordination between tax authorities and environmental agencies to accurately determine the tax payable by taxpayers and to monitor GHG emissions.

Source: The authors' synthesis

Based on the evaluation of the advantages and disadvantages of the two approaches to carbon tax, it can be seen that each method has its own distinct pros and cons. In order to determine the most suitable approach for the country, both Vietnam and Taiwan need to consider the following issues:

First, in terms of infrastructure and measurement systems

The MRV infrastructure in Vietnam is primarily concentrated in high-emission industries such as energy, cement, and steel. However, this infrastructure has not yet been widely deployed, and there are still significant gaps in sectors like agriculture and construction. Current measurement tools and technologies often rely on support from international cooperation projects, such as those from the United Nations Development Programme (UNDP) and the World Bank, but the development of a comprehensive measurement infrastructure still requires long-term investment from the government (United Nations Development Programme, 2021).

Although Vietnam has implemented some regulations requiring businesses to report their GHG emissions, the reporting system has not been consistently applied. Many businesses still lack the technical capability to accurately measure their emissions, resulting in incomplete or inaccurate reporting. The lack of clear standards on how to report is also a major challenge, making it difficult for regulatory agencies to collect and compile national GHG emission data (Ministry of Natural Resources and Environment, 2022).

One of the key elements of the MRV system is the process of validating and verifying emission reports from businesses. However, in Vietnam, this system has not been fully established. Currently, emission assessments are mainly conducted by government agencies, but the lack of involvement from independent third parties raise concerns about the accuracy and transparency of data verification. According to the Asian Development Bank (ADB), the lack of trained resources and a transparent verification mechanism are among the main barriers preventing Vietnam's MRV system from operating effectively (Asian Development Bank, 2020).

Similarly, Taiwan is in the process of developing a system for emissions measurement, reporting, and verification (Taiwan Climate Change Agency, n.d.). However, this system is not yet fully developed and has so far only focused on large facilities. This suggests that the direct emissions approach may not be immediately widespread, as the emissions measurement and monitoring system is not yet robust enough to manage the total emissions. The system is being implemented through compliance with government-prescribed procedures. Greenhouse gas emissions data are collected and calculated based on methods from the Intergovernmental Panel on Climate Change (IPCC). This system includes steps for measuring activities and emission factors, followed by reporting and verification to ensure data accuracy.

Therefore, the authors believe that the fuel-based approach would be easier to implement because it does not require a complex MRV system. Vietnam and Taiwan could impose a direct tax on imported fuels, utilizing the existing customs and tax systems. This allows for the quick application of a carbon tax without the need to immediately build a detailed emissions monitoring system.

Second, the goal of carbon neutrality and long-term strategy

Vietnam has set a target to achieve net-zero emissions by 2050. By 2030, Vietnam aims to reduce GHG emissions by 32.6% in energy, 43% in agriculture, 70% in forestry and land use, while increasing carbon absorption by 20%, 60.7% in waste treatment, and 38.3% in industrial processes (compared to the business-as-usual scenario). Similarly, Taiwan has also committed to achieving carbon neutrality by 2050 (National Development Council, n.d.).

To meet these commitments, both Vietnam and Taiwan must have long-term policies with strong measures to reduce emissions. In order to achieve these goals, both economies need to implement effective economic policy tools that ensure sustainable and equitable development. To ensure fairness in taxing GHG emissions through carbon tax, the MRV system will need to be improved and expanded, and the direct emissions approach will need to be gradually adopted. However, in the near future, to maintain simplicity and stability in the tax system, the carbon tax should initially follow the fuel-based approach, with a phased transition to the direct emissions approach, giving both countries' MRV systems time to develop fully.

Third, in terms of cost and management capability

The fuel-based approach will ensure low administrative costs and does not require complex systems, as it utilizes the existing tax systems in Vietnam and Taiwan. This allows both Vietnam and Taiwan to quickly implement and apply the carbon tax without the need for significant immediate investment in emission monitoring infrastructure, particularly in the development of the MRV system. In the longer term, when both Vietnam and Taiwan have fully integrated MRV systems into their carbon markets, the carbon tax can inherit these systems and transition to the direct emissions approach. Although this approach incurs higher management costs, it will offer greater fairness and effectiveness in controlling actual emissions from large facilities.

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The Potential of Employing Machine Learning in Assessing Social Vulnerability to Natural Hazards

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Abstract

The increasing frequency and intensity of natural hazards have highlighted the urgent need for more sophisticated methods to assess social vulnerability. Traditional statistical approaches, while valuable, often depend on assumptions that may not be universally applicable, particularly at regional levels, where the complexity and scale of data can challenge their effectiveness. This article examines the potential of machine learning (ML) as both an alternative and a complement to traditional methods in the assessment of social vulnerability to natural hazards. This research adopts a multifaceted methodology, integrating statistical techniques with comprehensive document reviews and in-depth content analysis of existing literature. By merging these approaches, the study seeks to provide a robust and nuanced understanding of the various factors contributing to social vulnerability. The findings underscore the ability of ML algorithms to handle large datasets, manage complex interactions among multiple indicators, and model non-linear relationships without relying on predefined assumptions about data distribution. These strengths make ML particularly effective for regional analyses, where social vulnerability is shaped by a diverse array of interconnected factors. Through a critical review of existing studies, this research identifies key trends, gaps, and methodological strengths within the current body of knowledge. The article argues that while ML shows significant promise in enhancing the accuracy and relevance of social vulnerability assessments, further research is necessary to refine these techniques and validate their application across different regional contexts. By advancing the use of ML in this field, we can develop more accurate, adaptable, and context-sensitive tools for assessing social vulnerability, ultimately contributing to the development of more resilient communities in the face of natural hazards.

Keywords: *Natural hazards, social vulnerability, machine learning, SOVI*

1. Introduction

Under the impact of climate change, communities, and systems are increasingly exposed to natural hazards at an unprecedented rate (UNDRR, 2022). Rapid population growth and urban expansion, often lacking appropriate and sustainable urbanization plans, have further exacerbated this exposure, particularly in low and middle-income countries. The absence of adequate urban development strategies, such as regulations to ensure construction quality, infrastructure integrity, and availability combined with socio-economic weaknesses like poverty, low quality of life, limited access to resources, poor livelihood opportunities, and low education levels, have made these countries increasingly vulnerable to natural hazards (Dodman et al., 2013; Mesta et al., 2022). To accurately assess the risk level of communities or systems to these hazards, it is not enough to merely calculate exposure levels; a thorough consideration of various aspects of vulnerability, including social vulnerability, is essential. This study focuses on the social dimension of vulnerability to natural hazards, following the UNDRR (2022) definition: “Social vulnerability includes conditions determined by physical, social, economic, and environmental factors or processes that increase the susceptibility of an individual, community, asset, or system to the impacts of hazards”. The research examines specific social factors that may amplify the adverse impacts of hazards on communities or systems, highlighting the importance of assessing social vulnerability to build more resilient societies. While numerous vulnerability assessments have been conducted to improve preparedness and resilience at different scales, few studies have focused on understanding the determinants of social vulnerability using machine learning (ML) techniques. Accordingly, the objective of this research is to explore the potential of applying ML in social vulnerability assessment through a systematic literature review and analysis of global studies. The aim is to develop an effective approach that can be applied across various contexts and levels to understand the determinants of social vulnerability using accessible databases. This research is organized into four sections: The introduction outlines the background and motivation for the research. The second section details the research methodology. The third section presents the findings, including an overview of social vulnerability assessments to natural hazards and a review of literature on social vulnerability and the methods used to measure it, with a particular focus on ML applications. Finally, the discussion and conclusion summarize the key points and suggest directions for future research in social vulnerability assessment using ML.

2. Methods

This research utilizes a multifaceted approach, incorporating in-depth content analysis existing literature in the field of social vulnerability assessment to natural hazards. By integrating these methodologies, the research aims to provide a robust and nuanced understanding of the various factors that contribute to social vulnerability, offering insights that are both data-driven and contextually grounded. This approach allows for a thorough examination of how different studies have addressed social vulnerability, identifying key trends, gaps, and methodological strengths in the existing research trends.

3. Results

3.1. Social vulnerability assessment research framework

In the ongoing efforts to assess risk and vulnerability, it has become increasingly clear that the exposure of communities or systems is not merely a function of their geographic location or physical environment. Rather, it is deeply influenced by a broad array of social, economic, institutional, and other contextual characteristics. Numerous studies have emphasized the importance of looking beyond exposure alone, asserting that the social dimension of vulnerability has emerged as a crucial focal point in disaster risk research. This approach is vital for comprehensively assessing and understanding the potential impacts of natural hazards (Fatemi et al., 2017; Burton et al., 2018; Shen et al., 2018; Wang and Sebastian, 2021). Social risk assessment within the field of natural hazard risk research seeks to address pivotal questions: What factors contribute to the vulnerability of communities or systems in the face of hazards? Why are certain communities more likely to reside in areas with high hazard exposure? These questions are essential for identifying social indicators of vulnerability and for explaining why communities with similar levels of exposure may experience drastically different degrees of adverse impacts.

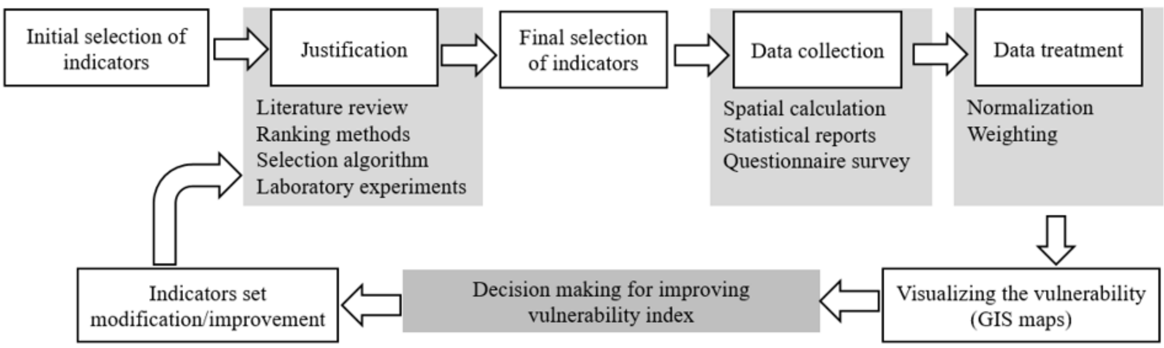

Figure 1: Main steps of a vulnerability assessment employing an indicator-based approach

Source: Nguyen et al, 2023

A wide range of studies conducted across the globe have contributed to the development of social vulnerability indicators, each providing unique insights into the role and influence of these indicators on vulnerability. Some of the most widely utilized indicators pertain to demographic composition and gender, with a particular emphasis on vulnerable groups such as the elderly, children, and women. These groups are often perceived as being more susceptible to the effects of natural hazards than other segments of the population. Research has consistently shown that children and individuals over the age of 65 are particularly vulnerable due to their physical health challenges and slower response capabilities in emergency situations (Fatemi et al., 2017). Over time, additional health-related indicators have been integrated into social vulnerability assessments, such as the proportion of people with disabilities. This inclusion reflects a growing recognition that individuals with disabilities face significant disadvantages in coping with the effects of hazards. The higher mortality rates observed among people with disabilities during large-scale disasters, such as earthquakes and floods, underscore the critical importance of considering this group in vulnerability assessments. Beyond demographic characteristics, socio-economic factors - including income levels, employment status, social security, and household size - play a significant role in shaping vulnerability (Holand et al., 2011). Furthermore, the distribution of labor within a community, which is closely tied to economic and income factors, can also influence how a community is affected by hazards (Enarson et al., 2018). In addition to socio-economic and demographic characteristics, the physical environment is frequently considered a key component in assessing social vulnerability. Factors such as the availability and quality of infrastructure, along with access to essential public resources like transportation, education, and healthcare, are critical. The absence or inadequacy of these conditions can significantly exacerbate a community's vulnerability to hazards (Holand and Lujala, 2013). Thus, the indicators necessary for assessing social vulnerability to hazards can be broadly categorized into three main groups: demographic, socio-economic, and physical aspect. While there is a degree of consensus on the importance of these indicators, accurately measuring them to calculate vulnerability remains a complex and challenging task, owing to the nuanced nature of the concept. Figure 1 presents main steps in the methodological flow of vulnerability assessment employing an indicator-based approach, and social vulnerability assessment also contains the same stages.

In many studies, the most commonly employed method for quantifying social vulnerability as a single numerical value is the deductive statistical model. These models typically involve the selection of a few highly representative indicators for a given study area, which are then standardized and summed to construct a vulnerability score (Tate, 2012; Bakkensen et al., 2017). One of the most widely recognized tools in this regard is the Social Vulnerability Index (SoVI), developed by Cutter et al. (2003). In their study, Cutter et al. utilized principal component analysis (PCA) to construct the SoVI based on 42 vulnerability indicators for counties across the United States. The resulting SoVI score is calculated by summing the raw data for each county, with higher scores indicating greater social vulnerability. Although the analytical framework proposed by Cutter et al. (2003) has been widely adopted, subsequent studies have pointed out that the indicators referenced by Cutter and colleagues are highly context-specific. As such, these indicators may require adjustment when applied to different locations or time periods (Bergstrand et al., 2015; Rufat et al., 2019; Mahbubur Rahman et al., 2023). Despite these limitations, the SoVI remains an invaluable tool for both researchers and policymakers, facilitating vulnerability assessments at various scales. However, vulnerability studies at the regional level are still relatively limited (Tasnuva et al., 2021). These studies are often highly dependent on the availability of data, which can pose significant challenges, particularly in contexts where data are scarce or where data-sharing protocols are insufficient. Moreover, at the regional level—where severe disaster risks may be infrequent—policymakers might underestimate the potential impact of a hazard event if they rely solely on historical data from smaller-scale events. In such cases, losses might have been mitigated by infrastructure investments, leading to a skewed perception of risk. Consequently, the lack of comprehensive data and the rarity of severe disasters can complicate efforts to use historical data in regional social vulnerability studies. Many existing studies have explored indicators related to social vulnerability through the use of descriptive statistics or traditional data analysis tools, such as linear or logistic regression. While descriptive statistics provide a basic understanding of individual indicators, they do not account for the complex relationships between them. Traditional statistical methods, on the other hand, often rely on assumptions about the data that may not hold true in all contexts. In recent years, machine learning (ML) algorithms have emerged as a promising alternative. These algorithms can process a larger number of indicators, handle complex interactions between them, and model non-linear relationships without requiring assumptions about data distribution. Given these advantages, ML methods present a compelling alternative to traditional statistical techniques, especially in studies conducted at larger scales, such as regional analyses. However, the application of ML in social vulnerability assessments is still in its early stages. Due to the relatively small number of studies, significant methodological differences, and limited performance evaluations of different ML methods, the accuracy and reliability of ML in assessing social vulnerability to natural hazards remain areas of ongoing exploration and development.

3.2. The potential of using machine learning in assessing social vulnerability to natural hazards

The application of machine learning (ML) in assessing social vulnerability to natural hazards, particularly at the regional level, presents a transformative potential, especially when compared to traditional statistical methods. Traditional approaches often rely on assumptions about data distribution and relationships among variables that may not hold true in different contexts. This limitation becomes more pronounced in regional analyses, where the complexity and scale of data can diminish the effectiveness of conventional methods. Machine learning algorithms offer a paradigm shift in social vulnerability assessments. Unlike traditional techniques, ML can process vast amounts of data and simultaneously incorporate a wide array of indicators. This capability is crucial at the regional level, where social vulnerability is shaped by diverse and interrelated factors such as demographic characteristics, socio-economic status, infrastructure quality, and environmental conditions. ML's strength lies in its ability to model complex, non-linear interactions among variables without the need for predefined assumptions about data relationships. This flexibility is particularly valuable in regional studies, where the dynamics between various indicators can vary significantly across different areas and populations. The advantages of ML extend beyond its capacity to handle larger datasets. ML algorithms can adapt to the specific characteristics of the region under study, offering more tailored and accurate vulnerability assessments. For instance, in regions where data is scarce or inconsistent, ML models can effectively leverage alternative data sources or impute missing values, outperforming traditional methods. This adaptability is essential in ensuring that social vulnerability assessments are both reliable and applicable to the unique challenges of each region. Furthermore, ML's ability to model non-linear relationships provides deeper insights into the multifaceted nature of social vulnerability. Traditional methods may oversimplify or overlook these complexities, leading to assessments that fail to fully capture the extent of vulnerability in certain communities. In contrast, ML can uncover hidden patterns and interactions critical in predicting the impact of natural hazards. This capacity to reveal nuanced insights makes ML a powerful tool for policymakers and researchers aiming to enhance disaster preparedness and resilience at the regional level.

Table 1: Recent publications that using ML in social vulnerability assessment

Publication	ML method	The scale of vulnerability assessment	Indicators	Key findings
Yoon and Jeong (2016)	Random forest (RF), Cubist	Local communities	12 indicators across social, economic, natural environment and built environment aspects.	This study examines the relationships between the constructed vulnerability indicators and economic damage from natural disasters. Machine learning techniques including Cubist and Random Forest are applied to examine what vulnerability indicators are statistically associated with disaster damage in Korea.
Alizadeh et al (2018)	Artificial Neural Network (ANN)	Municipality level	7 indicators were identified and used for earthquake vulnerability mapping, including population density, household density, employed density, unemployed density, and literate people.	This study presents the application of an artificial neural network (ANN) and geographic information system (GIS) for estimating the social vulnerability to earthquakes in the Tabriz city, Iran. The results highlight the importance of using social vulnerability study for defining seismic-risk mitigation policies, emergency management,

Publication	ML method	The scale of vulnerability assessment	Indicators	Key findings
				and territorial planning in order to reduce the impacts of disasters.
Zhang et al (2023)	Naïve Bayes (NB), K-Nearest Neighbors (KNN), Logistic Regression (LR), Random Forest (RF), and K-Means (KM)	84 watersheds and 144 cities in Idaho	29 indicators including population; ages range; accessibility to health services, transportation, education; language used,	The results indicate that RF model performs best in both hazard-related and social vulnerability datasets of cities in Idaho. This study generates a multi-hazards risk map which show a wide variety of spatial patterns and a corresponding understanding of where regional high hazards potential and vulnerable areas are.

Source: Author's synthesis

However, the application of ML in social vulnerability assessments is still in its early stages. The relatively small number of studies in this area, along with significant methodological variations and limited performance evaluations of different ML techniques, means that the full potential of ML has yet to be realized (Table 1). More extensive research is needed to refine these methods, establish best practices, and validate their effectiveness across diverse regional contexts. Despite these challenges, the promise of ML in this field is undeniable. As research continues to evolve, ML has the potential to revolutionize how we assess and address social vulnerability to natural hazards at the regional level. By offering more accurate, flexible, and insightful analyses, ML can help create more resilient communities better equipped to withstand the impacts of natural hazards.

4. Discussion and Conclusion

The integration of machine learning (ML) into social vulnerability assessments for natural hazards marks a significant advancement, especially when dealing with complex and variable data at the regional level. Traditional statistical methods, while valuable, often struggle to capture the intricate, non-linear relationships between the many factors that contribute to social vulnerability. In contrast, ML offers a more robust and adaptable framework, making it an invaluable tool in this field. Another challenge in social vulnerability assessments is that this complex assessment requires specialized knowledge and statistical expertise to implement; hence, in many case studies, the difficulty is the reliance on expert consultations. Although experts provide crucial insights based on their experience and understanding of specific hazards, their evaluations can sometimes be subjective, influenced by personal biases, or limited by the scope of their expertise. This subjectivity can lead to inconsistencies, particularly when assessments are conducted across diverse regions or in response to new, unforeseen hazards. ML addresses these challenges by introducing an objective, data-driven approach that complements expert input. ML algorithms can process large datasets that encompass a wide range of indicators, such as demographic characteristics, socio-economic conditions, and environmental factors. By identifying patterns and interactions within the data that may not be immediately apparent to human analysts, ML helps reduce the subjectivity inherent in expert evaluations, leading to more consistent and reliable assessments. For example, methods like decision trees, random forests, and support vector machines can model complex relationships and provide insights into how different factors interact to influence vulnerability. Moreover, ML's ability to handle non-linear and complex interactions is particularly valuable in regional studies, where the factors influencing vulnerability can vary widely across different populations and environments. Unlike traditional methods, which often rely on linear assumptions, ML can adapt to the specific characteristics of the region under study, enhancing the accuracy of assessments and making the findings more relevant and actionable for policymakers and disaster management professionals.

Another significant advantage of using ML in social vulnerability assessments is its potential for improving future forecasting. By analyzing historical data, ML models can identify trends and predict the impacts of natural hazards with greater precision. This predictive capability is crucial for proactive disaster risk reduction, enabling communities to prepare for and mitigate the effects of potential hazards more effectively. However, it is important to recognize that the use of ML does not replace the need for expert consultation. Instead, ML should be seen as a complementary tool that enhances the overall assessment process. Experts are essential for interpreting the results generated by ML models and providing the contextual understanding necessary to apply these findings effectively. The synergy between expert knowledge and ML can lead to more robust and comprehensive vulnerability assessments, ultimately contributing to the development of more resilient communities.

In conclusion, the application of machine learning in assessing social vulnerability to natural hazards offers a powerful and innovative approach that overcomes the limitations of traditional statistical methods. By reducing subjectivity, modeling complex interactions, and improving predictive accuracy, ML provides a more objective and adaptable framework for vulnerability assessments. While expert consultation remains critical, ML enhances the consistency, reliability, and relevance of these assessments, making them more useful for policymakers and disaster management professionals. As the field of ML continues to evolve, further research is needed to refine these methods and validate their effectiveness across different contexts. Nonetheless, the potential of ML in this area is undeniable, offering a promising pathway for creating more resilient communities better equipped to withstand the impacts of natural hazards.

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Resilience and Risk: How Climate Change Will Shape the Future of Private Health Insurance in Vietnam

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Abstract

This article examines the impact of climate change on Vietnam's private health insurance market using synthesis and statistical analysis, supported by data from VCCI, ADB, VMHA, the World Bank, and VIA. It highlights how rising temperatures, more frequent extreme weather events, and related health risks are increasing the demand for health services and insurance coverage. These pressures are driving up healthcare costs and insurance premiums, threatening the affordability and accessibility of private health insurance in Vietnam. To address these challenges, the article proposes actionable solutions for stakeholders, including the development of climate-resilient insurance products, enhancing risk assessment frameworks, and fostering collaboration between insurers and government agencies. These strategies aim to ensure that the private health insurance sector remains resilient and capable of protecting the Vietnamese population from the growing health risks posed by climate change. By implementing these recommendations, the article suggests that stakeholders can mitigate the adverse effects of climate change on the insurance market, ensuring its long-term sustainability and effectiveness in safeguarding public health in a rapidly changing environment.

Keywords: *Climate changes, health risks, private health insurance*

1. Introduction

Climate change is recognized as one of the most significant challenges of the 21st century, affecting nearly every aspect of life on Earth. It is characterized by long-term shifts in temperature and weather patterns, primarily driven by anthropogenic activities such as the burning of fossil fuels, deforestation, and large-scale industrial processes (IPCC, 2021). According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures have already risen by approximately 1.1°C since the late 19th century, with wide-reaching consequences for natural ecosystems, human societies, and economies worldwide (IPCC, 2021).

The global impact of climate change is extensive and multifaceted. Rising temperatures are contributing to the melting of polar ice caps and glaciers, which in turn is causing sea levels to rise and threatening coastal communities (IPCC, 2021). The frequency and intensity of extreme weather events, such as hurricanes, floods, and droughts, have also increased, resulting in significant economic losses and displacement of populations (UNDRR, 2020). Moreover, climate change is affecting global ecosystems, leading to shifts in species distributions, changes in biodiversity, and disruptions to food security, water availability, and public health (World Health Organization (WHO, 2021).

Vietnam is among the countries most vulnerable to the impacts of climate change due to its geographical location, long coastline, and high population density. The country is particularly at risk from rising sea levels, which threaten the Mekong Delta—a critical region for agriculture and food production. The World Bank estimates that a sea-level rise of one meter could displace millions of people and submerge significant portions of arable land in Vietnam (World Bank, 2020). This would have devastating effects on food security, livelihoods, and economic stability in the region. In addition to sea-level rise, Vietnam is experiencing increased temperatures, more frequent and intense typhoons, and changes in precipitation patterns. These climate-related events are likely to exacerbate existing social and economic inequalities, particularly in rural and coastal communities where people depend heavily on agriculture and natural resources for their livelihoods (Asian Development Bank - ADB, 2020). The health impacts of these changes are already evident, with rising incidences of heat-related illnesses, vector-borne diseases such as dengue fever, and respiratory problems linked to air pollution and higher temperatures (WHO, 2021).

As Vietnam continues to develop its healthcare system, private health insurance is becoming increasingly important for providing access to medical services and financial protection against healthcare costs. The public healthcare system in Vietnam, while extensive, faces challenges such as overcrowding, limited resources, and varying quality of care (Minh, 2019). Private health insurance offers an alternative by enabling individuals to access higher-quality healthcare services, reduce out-of-pocket expenses, and receive timely treatment, especially in cases of serious or chronic illnesses (Nguyen & Pham, 2021).

The importance of private health insurance is expected to grow as climate change intensifies and the associated health risks increase. The demand for healthcare services is likely to rise, putting additional pressure on both public and private healthcare systems. In this context, private health insurance can play a crucial role in mitigating the financial burden on individuals and families, ensuring that they have access to necessary medical care without facing financial ruin (ADB, 2020). Additionally, private insurers have the opportunity to develop specialized insurance products that address the specific health risks posed by climate change, thereby enhancing the resilience of the population (WHO, 2021).

This paper aims to explore the potential impacts of climate change on the future of private health insurance market in Vietnam. It will examine the specific health risks posed by climate change, including both direct and indirect impacts on public health, and analyze how these risks may affect the demand for and provision of private health insurance. Furthermore, the essay will consider the challenges and opportunities for insurers as they adapt to the evolving climate landscape, including the need for innovative insurance products, pricing strategies, and risk management approaches. By doing so, the essay seeks to provide insights into the critical role that private health insurance can play in enhancing Vietnam’s resilience to climate change and ensuring the long-term health and well-being of its population.

2. Methods

The article used the method of synthesis and statistical analysis. Data sources are taken from VCCI, ADB, VMHA, World bank, VIA reports for summarizing and analysis. The article describes climate change’s effects on the private health insurance market and then suggests some solutions to improve market performance to stakeholders.

3. Results

3.1. Climate change in Vietnam: Current trends and future projection

Vietnam is characterized by a tropical monsoon climate, with distinct wet and dry seasons that vary across the country’s diverse regions. The northern part of Vietnam experiences four distinct seasons, while the southern region typically experiences a more tropical climate with a pronounced rainy season. Vietnam's extensive coastline, spanning over 3,000 kilometers, combined with its mountainous regions, contributes to its diverse climatic conditions. However, this geographic diversity also makes Vietnam particularly vulnerable to the impacts of climate change, which is already manifesting in various forms across the country.

Vietnam has already begun to experience the significant effects of climate change, which are threatening its economy, environment, and public health. One of the most pronounced impacts is the rising temperature across the country. Data from the Vietnam Meteorological and Hydrological Administration (VMHA) indicates that the average temperature in Vietnam has increased by approximately 0.5 to 0.7°C over the past 50 years (VMHA, 2021). This warming trend has contributed to more frequent and intense heatwaves, particularly in urban areas, exacerbating health issues such as heat-related illnesses and respiratory conditions. Another critical impact of climate change in Vietnam is sea-level rise. The Mekong Delta, one of the country’s most productive agricultural regions, is particularly at risk. According to the World Bank, sea levels along Vietnam's coast have been rising at an average rate of 3 millimeters per year, a rate that is expected to accelerate (World Bank, 2020). A report by the Vietnam Institute of Meteorology, Hydrology and Climate Change (IMHEN) in 2023 highlighted that over 40% of the Mekong Delta's area is now regularly exposed to salinity levels above 4 grams per liter, a threshold beyond which most rice varieties cannot survive. The salinization of water sources also poses significant risks to freshwater supplies, further threatening the livelihoods and food security of millions of people.

Additionally, Vietnam is witnessing an increased frequency and severity of natural disasters. The country is highly susceptible to typhoons, floods, and droughts, all of which are becoming more intense due to climate change. In 2023, Vietnam witnessed over 1,100 natural disasters, causing 166 deaths and missing people, and causing damage of over 8,000 billion VND (Vietnam Disaster Management Authority, 2023). These disasters not only cause immediate harm but also have long-term effects on the country's economic development and social stability.

Climate models predict that Vietnam will continue to face severe climate-related challenges. According to the Intergovernmental Panel on Climate Change (IPCC), if global temperatures continue to rise at the current rate, Vietnam could experience an increase in average temperatures by as much as 2 to 3°C by the end of the century (IPCC, 2021). This warming is expected to lead to more prolonged and severe heatwaves, which will have serious implications for public health, particularly in densely populated urban areas.

Furthermore, the frequency and intensity of extreme weather events, such as typhoons and floods, are expected to increase. The Asian Development Bank (ADB) projects that by 2050, the economic losses from climate-related disasters in Vietnam could exceed 3% of the country’s GDP annually (ADB, 2020). These projections underscore the urgent need for comprehensive climate adaptation and mitigation strategies to safeguard Vietnam’s future.

3.2. Health impacts of climate change in Vietnam

Climate change has direct and profound effects on public health in Vietnam, a country particularly vulnerable to the impacts of global warming. One of the most significant direct health impacts is the increase in heat-related illnesses. As average temperatures rise and the frequency of heatwaves intensifies, more people are experiencing conditions such as heat exhaustion, heatstroke, and exacerbations of pre-existing cardiovascular and respiratory diseases. The Vietnam Meteorological and Hydrological Administration (VMHA) reported that the average annual temperature in Vietnam has increased by 0.5-0.7°C over the past 50 years, leading to more frequent and severe heatwaves, particularly in urban areas (VMHA, 2021).

Heatwaves not only increase mortality rates but also strain the healthcare system, as more individuals require emergency care during extreme heat events. The elderly, children, and those with pre-existing health conditions are particularly at risk. According to a study by the World Health Organization (WHO), the mortality rate in Hanoi and Ho Chi Minh City increased by 5-7% during heatwaves, with the highest risk among the elderly population (WHO, 2021).

In addition to heat-related illnesses, respiratory diseases are also on the rise due to climate change. Increased temperatures and prolonged heatwaves exacerbate air pollution, particularly in densely populated urban areas. The combination of higher temperatures and increased levels of pollutants, such as particulate matter (PM2.5), has been linked to higher incidences of respiratory conditions like asthma, chronic obstructive pulmonary disease (COPD), and other lung diseases (Nguyen et al., 2022). These conditions are expected to worsen as climate change progresses, leading to higher healthcare costs and reduced quality of life for affected populations.

Climate change also has numerous indirect health impacts, particularly through its influence on the spread of infectious diseases. One of the most concerning indirect effects is the increased incidence of vector-borne diseases, such as dengue fever. Vietnam has seen a significant rise in dengue cases, attributed to changes in temperature and precipitation patterns that create favourable conditions for the Aedes mosquito, the primary vector of the disease. According to the Ministry of Health, Vietnam recorded over 320,000 cases of dengue fever in 2022, with the incidence rate doubling in some regions compared to previous years (Ministry of Health, 2023). Waterborne diseases are another significant concern. Flooding, which has become more frequent and severe due to climate change, often leads to the contamination of drinking water sources with pathogens such as Vibrio cholerae and Escherichia coli. Outbreaks of diseases like cholera and dysentery are more common in the aftermath of floods, particularly in rural areas with inadequate sanitation infrastructure. The WHO has identified Vietnam as a high-risk country for waterborne diseases, with climate change expected to exacerbate these risks in the coming decades (WHO, 2022).

Beyond direct and indirect health impacts, climate change significantly influences the social determinants of health in Vietnam. Displacement due to rising sea levels, increased frequency of natural disasters, and the degradation of arable land are leading to higher levels of poverty and food insecurity. The Mekong Delta, home to millions of people and a critical region for rice production, is particularly vulnerable. Rising sea levels and saltwater intrusion are reducing agricultural productivity, which in turn affects food availability and prices (World Bank, 2020). The displacement of communities due to climate-related events is becoming more common. As people are forced to move from their homes, often to urban areas, they face numerous health challenges, including access to clean water, sanitation, and healthcare services. These displaced populations are at a higher risk of malnutrition, infectious diseases, and mental health issues. The Vietnam Red Cross has reported an increase in mental health problems among displaced populations, linked to the stress and trauma of losing homes and livelihoods (Vietnam Red Cross, 2022).

3.3. The role of private health insurance in Vietnam's healthcare system

Vietnam's healthcare system is characterized by a mix of public and private healthcare providers, with the public sector playing a dominant role. The Ministry of Health (MOH) oversees the healthcare system, which is organized into four administrative levels: central, provincial, district, and commune. Public hospitals and clinics at these levels provide a wide range of services, from primary care to specialized treatments. Vietnam's public healthcare system is heavily subsidized by the government, ensuring that a majority of the population has access to basic healthcare services (World Bank, 2020). Howerver out of pocket rate for health expenditure remains relatively high, around 40% in 2021 (World bank, 2022).

The public healthcare system in Vietnam has made significant strides in improving health outcomes over the past few decades. The country has achieved substantial reductions in infant mortality and maternal mortality rates, and life expectancy has increased steadily. However, the system faces several challenges, including overcrowding in hospitals, disparities in healthcare access between urban and rural areas, and limited financial resources. These challenges have led to a growing demand for private healthcare services, particularly among the middle and upper classes (Nguyen & Wilson, 2021).

Private health insurance plays an increasingly important role in Vietnam's healthcare system, particularly as the country's economy grows and more people seek higher-quality healthcare services. While public health insurance is mandatory and covers a majority of the population, it often provides limited coverage, particularly for advanced treatments and specialized care. Private health insurance serves as a supplementary option, offering access to private healthcare providers, shorter waiting times, and more comprehensive coverage for medical services not fully covered by the public system (Minh et al., 2018). This insurance line provides beneficiaries with access to a broader network of private hospitals and clinics, which are often perceived as offering higher standards of care compared to public facilities. These private facilities are generally better equipped, less crowded, and provide more personalized services, making them an attractive option for those who can afford the premiums. Furthermore, private health insurance policies often cover a wider range of services, including dental care, maternity care, and outpatient services, which are not always fully covered by public health insurance (Nguyen et al., 2019). The rise of private health insurance has also contributed to the overall improvement of healthcare services in Vietnam by fostering competition between public and private providers. This competition has encouraged public hospitals to improve their services and efficiency, benefiting all patients, regardless of whether they are insured privately or publicly (World Bank, 2020).

The private health insurance sector in Vietnam has grown significantly in recent years, driven by rising incomes, increasing awareness of health risks, and dissatisfaction with the limitations of the public healthcare system. According to the Insurance Association of Vietnam (IAV), the number of people with private health insurance increased by 15% annually over the past five years, reaching approximately 10 million policyholders by 2022 (IAV, 2023).

Table 1: Premium revenue of health insurance business in Vietnam from 2018-2023 (Billion VND)

Indicators	2018	2019	2020	2021	2022	2023
Revenue	14.466	17.361	18.270	18.021	23.703	23.736
Growth Rate	-	20,01%	5,24%	-1,36%	30,53%	0,14%
Total Market Reveneu	46.957	53.369	56.669	57.880	69.161	71.038
Market share by Business	30.81%	32.53%	32.24%	31.14%	34.27%	33.41%

Source: IVA reports

Despite this growth, the private health insurance sector in Vietnam faces several challenges. One of the primary challenges is the affordability of premiums. While private health insurance provides better access and coverage, the cost is often prohibitive for low- and middle-income households. This has led to concerns about equity in healthcare access, as only a small portion of the population can afford private health insurance (Pham, 2022). Another challenge is the lack of transparency and standardization in the private health insurance market. Policyholders often face difficulties in understanding the terms and conditions of their policies, including what is covered and the procedures for claiming benefits. This lack of transparency can lead to disputes between insurers and policyholders, undermining trust in the private insurance system (Nguyen et al., 2019). Moreover, the private health insurance sector is also challenged by the need to adapt to the changing health landscape, particularly in the context of rising healthcare costs and the increasing prevalence of chronic diseases. Insurers must balance the need to provide comprehensive coverage with the need to maintain financial sustainability, which requires careful management of premiums and benefits (Minh et al., 2018)

3.4. Implications of climate change for private health insurance in Vietnam

As Vietnam experiences the growing impacts of climate change, there has been a noticeable increase in the demand for health services, particularly those addressing climate-related health issues. Rising temperatures, more frequent extreme weather events, and changing patterns of infectious diseases are contributing to a higher incidence of health problems such as heat-related illnesses, respiratory conditions, and vector-borne diseases like dengue fever. According to the World Health Organization (WHO), climate change is expected to exacerbate these health risks, leading to a significant increase in healthcare utilization (WHO, 2021). Ministry of Health reported that hospital admissions due to heat stress and respiratory issues rose by 20% during recent heatwaves, reflecting the direct impact of climate change on public health (Ministry of Health, 2022). This growing demand for health services is putting additional pressure on Vietnam’s healthcare system, particularly in urban areas where the effects of heatwaves and air pollution are most pronounced. The increasing burden of climate-related health issues is likely to drive more people to seek private health insurance as a means of accessing timely and higher-quality healthcare services, further straining the private health insurance sector.

The increased demand for healthcare services due to climate-related health issues is also leading to rising healthcare costs. Treating chronic conditions exacerbated by climate change, such as cardiovascular and respiratory diseases, as well as managing the spread of infectious diseases like dengue fever, requires significant healthcare resources. Asian Development Bank (ADB) estimates that the healthcare sector in Vietnam could face a 15% increase in costs over the next decade as a direct result of climate-related health impacts (ADB, 2020). These rising healthcare costs are likely to have a substantial impact on private health insurance premiums. As healthcare providers face higher operational costs, these expenses are often passed on to insurers, who, in turn, increase premiums to maintain financial viability. According to the Insurance Association of Vietnam (IAV), insurance premiums have already risen by an average of 10% annually, partly due to the growing costs associated with treating climate-related health conditions (IAV, 2022). This trend raises concerns about the affordability of private health insurance, particularly for low- and middle-income households, potentially exacerbating health inequities.

Climate change is also driving significant changes in the risk assessment and underwriting processes within the private health insurance sector. As the frequency and severity of climate-related health issues increase, insurers must re-evaluate the risks associated with providing coverage. This involves developing new models for assessing the likelihood of claims related to climate-induced illnesses and adjusting underwriting criteria to reflect these emerging risks. Thus, insurers may need to take into account factors such as geographic location, occupation, and pre-existing health conditions more closely when determining coverage and premiums. People living in areas prone to extreme weather events or those working in outdoor occupations may be considered higher risk, resulting in higher premiums or more stringent underwriting requirements (Nguyen & Pham, 2021). Additionally, insurers may need to integrate advanced data analytics and climate modelling into their risk assessment processes to better predict and manage the impacts of climate change on health.

The evolving risk landscape due to climate change also presents an opportunity for private health insurers to develop new insurance products tailored specifically to climate-related health risks. As awareness of these risks grows, there is likely to be increased demand for insurance products that provide coverage for conditions directly linked to climate change, such as heat-related illnesses, respiratory conditions exacerbated by air pollution, and vector-borne diseases. Insurers could also explore offering products that incentivize preventive health measures, such as discounts for policyholders who engage in activities that reduce their vulnerability to climate-related health risks, such as installing air conditioning or using insect repellent in areas prone to mosquito-borne diseases (Minh et al., 2020). These innovative products could help insurers meet the growing demand for climate-resilient health coverage while also promoting public health and reducing overall healthcare costs.

3.5. International experiences

As the global impacts of climate change become more pronounced, several countries are developing innovative strategies to address the intersection of climate change and health insurance. These approaches provide valuable insights and models that can be adapted to the Vietnamese context.

Germany is one such example, where climate change has been integrated into health insurance through comprehensive risk assessments and the promotion of preventive measures. German insurers have begun to offer products that incentivize policyholders to adopt more sustainable lifestyles, which can help mitigate the impacts of climate change on health. For instance, discounts are offered to individuals who take steps to reduce their carbon footprint or engage in activities that promote resilience against climate-related health risks, such as participating in heatwave preparedness programs or maintaining healthy indoor air quality (Bundesministerium für Gesundheit, 2021).

Australia has also taken proactive measures to integrate climate considerations into its health insurance sector. Recognizing the increasing frequency of extreme weather events, such as bushfires and heatwaves, Australian insurers have developed products that specifically cover health conditions exacerbated by climate change. These include policies that provide coverage for respiratory conditions linked to air pollution from bushfires and skin cancer, which is more prevalent due to increased ultraviolet radiation exposure (Australian Government, 2020). Moreover, insurers in Australia collaborate closely with public health agencies to promote awareness and preparedness for climate-related health risks, ensuring that policyholders are better protected and informed.

In Vietnam, while the intersection of climate change and health insurance is still an emerging field, there are already some initiatives and case studies that offer insights into how the country is beginning to address these challenges.

A notable example is the pilot project launched by **Bao Viet Insurance**, one of Vietnam’s leading insurance companies, in collaboration with the Vietnam Ministry of Health. This project, which began in 2021, aims to develop insurance products that specifically target health risks associated with climate change, such as dengue fever and heatstroke. The project also includes educational campaigns to raise awareness about the health impacts of climate change and promote preventive measures among policyholders. Early results indicate that policyholders who participated in the educational component of the program were better prepared to manage climate-related health risks, resulting in fewer claims and better health outcomes (Bao Viet Insurance, 2022).

Another relevant case study comes from **Bangladesh**, a country with a similar climate and socioeconomic context to Vietnam. Bangladesh has implemented community-based health insurance schemes that are designed to be flexible and responsive to the health impacts of climate change. These schemes, often supported by non-governmental organizations (NGOs), provide affordable coverage to vulnerable populations who are most at risk from climate-induced health issues, such as those living in flood-prone areas. The success of these schemes in Bangladesh suggests that similar models could be adapted to rural and underserved areas in Vietnam, where climate impacts are most severe (Ahmed & Ahmed, 2019).

3.6. Future strategies for the private health insurance sector in Vietnam

As climate change continues to impact public health in Vietnam, the private health insurance sector must develop adaptive strategies to address emerging risks. One key approach is product innovation. Insurers can create new insurance products specifically tailored to the health challenges posed by climate change. For instance, policies could include coverage for conditions exacerbated by climate change, such as heat-related illnesses, respiratory conditions due to worsening air quality, and vector-borne diseases like dengue fever, which are becoming more prevalent due to changing weather patterns (Minh et al., 2020). Offering comprehensive coverage for these conditions will not only meet the growing demand but also position insurers as proactive players in the fight against climate-related health risks.

Another crucial strategy is the use of data analytics. By leveraging big data and advanced analytics, insurers can better understand the changing health risks associated with climate change and adjust their underwriting processes accordingly. Data analytics can help identify high-risk areas, predict the incidence of climate-related illnesses, and refine risk assessment models to more accurately price insurance products. This approach not only helps in managing risks but also enables insurers to offer more personalized and fair pricing to policyholders, enhancing customer satisfaction and retention (Nguyen & Pham, 2021).

Customer education is also an essential strategy. Insurers should invest in educating their customers about the health risks associated with climate change and the importance of having adequate insurance coverage. This can be done through awareness campaigns, workshops, and digital platforms that provide information on preventive measures and the benefits of climate-related health insurance products. Educated customers are more likely to take proactive steps to protect their health and seek appropriate coverage, which can reduce claims and improve the overall sustainability of the insurance sector (WHO, 2021).

Collaboration with healthcare providers and government agencies is critical for the private health insurance sector to effectively address the challenges posed by climate change. Insurers must work closely with healthcare providers to ensure that the healthcare system is equipped to handle the increasing demand for services related to climate-induced health issues. This collaboration could involve joint initiatives to enhance the capacity of healthcare facilities, such as investing in infrastructure that can withstand extreme weather events and ensuring the availability of necessary medical supplies and treatments (World Bank, 2020).

Moreover, partnerships with government agencies are essential for aligning insurance products with national health policies and climate adaptation strategies. By working together, insurers and government bodies can develop regulatory frameworks that support the growth of climate-resilient health insurance products. Government incentives, such as tax breaks for insurers who offer climate-focused products or subsidies for low-income individuals to purchase such insurance, can further encourage the development of this market. Additionally, collaboration with public health agencies can help insurers access critical data on climate-related health trends, which can inform product development and risk assessment (ADB, 2020).

To ensure long-term sustainability and resilience, the private health insurance sector in Vietnam must adopt comprehensive planning strategies that take into account the ongoing and future impacts of climate change. This involves not only adapting current products and practices but also planning for potential future scenarios. Insurers should conduct regular risk assessments to evaluate the long-term viability of their portfolios in the face of increasing climate risks. This may include stress testing to understand the financial impact of extreme climate events on their business and adjusting their investment strategies to reduce exposure to climate-sensitive assets (Nguyen et al., 2019).

Furthermore, building resilience within the insurance sector is crucial. This can be achieved by diversifying risk, such as through reinsurance arrangements that spread climate-related risks across global markets. Insurers should also consider integrating environmental, social, and governance (ESG) criteria into their business models, ensuring that their operations contribute to broader sustainability goals and are less vulnerable to climate-related disruptions (Minh et al., 2020).

In conclusion, the private health insurance sector in Vietnam must adopt a multifaceted approach to address the challenges posed by climate change. Through product innovation, data-driven strategies, customer education, and collaboration with healthcare providers and government agencies, insurers can build a resilient and sustainable business model. Long-term planning and resilience-building efforts will be essential for navigating the uncertainties of a changing climate and ensuring that the insurance sector continues to provide essential protection to the Vietnamese population.

4. Conclusion

This research has explored the multifaceted relationship between climate change and the private health insurance sector in Vietnam. Key findings include the increasing demand for health services due to the rising prevalence of climate-related health issues such as heat-related illnesses, respiratory conditions, and vector-borne diseases. The essay also highlighted the growing costs associated with treating these conditions, which are likely to drive up insurance premiums and challenge the affordability of private health insurance. Moreover, the need for insurers to adapt their risk assessment and underwriting processes to account for the evolving climate risks was discussed, alongside the potential for developing new insurance products tailored to these emerging challenges. Regulatory and policy considerations were also examined, emphasizing the need for adjustments in insurance regulations to better manage climate-related risks and promote the development of climate-resilient insurance products.

The findings underscore the critical importance of proactive adaptation by the private health insurance sector in Vietnam. As the impacts of climate change intensify, insurers must not only adjust their existing models but also innovate to stay ahead of the curve. This involves leveraging data analytics to refine risk assessments, developing new insurance products that address specific climate-related health risks, and educating customers about the importance of climate-resilient health coverage. Furthermore, collaboration with healthcare providers and government agencies is essential to ensure that the insurance sector can effectively support national climate adaptation strategies and contribute to broader public health goals. By taking these proactive steps, the private health insurance sector can mitigate the risks posed by climate change and continue to provide essential protection to individuals and businesses across Vietnam.

The future of health insurance in a climate-affected Vietnam will be shaped by the sector's ability to adapt to a rapidly changing environment. The increasing frequency and severity of climate-related events present both challenges and opportunities for insurers. Those who are able to innovate and respond effectively to these challenges will be well-positioned to thrive in the coming decades. However, failure to adapt could lead to increased financial strain on insurers, higher premiums for consumers, and reduced access to essential healthcare services for vulnerable populations.

In conclusion, the intersection of climate change and health insurance represents a critical area of focus for Vietnam as it navigates the impacts of global warming. By embracing proactive adaptation, fostering innovation, and strengthening collaborations, the private health insurance sector can play a vital role in enhancing the country's resilience to climate change. This will not only ensure the continued viability of the insurance industry but also contribute to the overall well-being and health security of the Vietnamese population in an increasingly climate-affected world.

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Urban Climate Change Adaptation: The case of Vietnam

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Abstract

This paper explores the ongoing efforts and challenges associated with urban climate change adaptation in Vietnam, with a focus on integrating climate-resilient infrastructure and policy frameworks and enhancing the role of local communities in building adaptive capacity. Using a qualitative research approach, the study investigates the complex relationship between urbanization and climate change, drawing on two case studies from Vietnam's major cities: Da Nang, which is advancing green infrastructure integration, and Ho Chi Minh City, which is addressing urban flood risks. Through these case studies, the research provides insights into the effectiveness of current adaptation strategies and offers recommendations for improving future urban resilience efforts in Vietnam.

Keywords: *Adaptation, climate change, resilience, urbanization, Vietnam*

1. Introduction

Climate change poses significant challenges to urban areas, particularly in rapidly developing nations such as Vietnam. As one of the most climate-vulnerable countries in the world, Vietnam is increasingly exposed to extreme weather events, rising sea levels, and urban flooding, all of which threaten the livelihood and infrastructure of its growing urban population (World Bank, 2021). Urban centers like Ho Chi Minh City and Da Nang face increasing risks due to their coastal locations, rapid urbanization, and insufficient adaptation strategies.

In response to these challenges, Vietnam has begun to integrate climate-resilient infrastructure into its urban development plans. This includes strengthening flood defense systems, improving water management, and upgrading housing to withstand extreme weather events (Rana et al., 2022). Additionally, national and local governments are working to develop comprehensive policy frameworks that address urban climate change adaptation, with the goal of minimizing the socio-economic impacts of climate-related hazards (UN-Habitat, 2015).

However, significant challenges remain in the implementation of these strategies. The integration of adaptation measures into urban planning is often hindered by limited financial resources, gaps in governance, and the need for more robust technical expertise (Ho et al., 2014). Furthermore, the role of local communities in building adaptive capacity has not been fully leveraged. Communities are vital to the success of adaptation initiatives, yet their involvement in decision-making processes and on-the-ground implementation remains limited.

This paper examines the ongoing efforts and challenges of urban climate change adaptation in Vietnam, focusing on the integration of climate-resilient infrastructure, policy frameworks, and the role of local communities in building adaptive capacity. By analyzing case studies from Vietnam's major cities, this research aims to provide insights into the effectiveness of current adaptation strategies and offer recommendations for future improvements.

2. Literature review

2.1. Governance and policy responses

Urban climate change adaptation requires robust governance frameworks and policy responses that address the complexities of urban environments and their unique vulnerabilities to climate impacts. Governance involves not only government actions but also the roles of private sector, civil society, and community organizations in planning and implementing adaptation strategies.

One of the key challenges in urban climate governance is the integration of climate adaptation into existing urban planning processes. Traditional urban planning has often been reactive, responding to climate impacts as they occur rather than proactively preparing for them. However, as cities face increasing risks from climate change, there has been a shift towards anticipatory governance, which emphasizes foresight and preparedness (Fünfgeld & McEvoy, 2014). Anticipatory governance involves the incorporation of climate risk assessments into urban planning and the development of flexible policy frameworks that can evolve in response to new climate information.

Urban governance for climate adaptation also involves the coordination across different levels of government and sectors. Local governments play a critical role in implementing adaptation measures, but they often require support from national governments in the form of funding, technical assistance, and policy guidance. This multi-level governance approach ensures that adaptation strategies are comprehensive and aligned with broader national and international climate goals (Juhola & Westerhoff, 2011). Furthermore, the integration of climate adaptation into urban policy often requires cross-sectoral collaboration, as climate impacts do not respect sectoral boundaries. For example, urban heat islands may require coordinated action across the sectors of public health, urban planning, and energy management.

The governance of urban climate adaptation also faces challenges related to equity and justice. Climate change impacts are often unevenly distributed, with marginalized communities bearing a disproportionate burden. Governance frameworks must therefore address these disparities by ensuring that adaptation strategies are inclusive and equitable. This may involve participatory governance approaches, where communities, particularly vulnerable groups, are actively involved in the decision-making process (Anguelovski et al., 2016). Moreover, policies should be designed to protect vulnerable populations from displacement and to ensure that adaptation measures do not exacerbate existing inequalities.

In summary, effective governance for urban climate adaptation requires anticipatory planning, multi-level and cross-sectoral coordination, and a focus on equity and justice. These elements are essential for creating resilient urban environments that can withstand the challenges posed by climate change.

2.2. Infrastructure development and resilience

Urban infrastructure is at the forefront of climate adaptation efforts, as it is both highly vulnerable to climate impacts and a critical component of urban resilience. Infrastructure systems such as transportation, water supply, energy, and waste management are essential for the functioning of cities, but they are also susceptible to damage from extreme weather events, sea-level rise, and other climate-related hazards.

Resilient infrastructure development involves designing and retrofitting urban systems to withstand climate impacts and to continue functioning under changing conditions. This often requires significant investment in upgrading existing infrastructure and constructing new systems that are more robust and adaptable. For example, in coastal cities, infrastructure projects may include the construction of sea walls, storm surge barriers, and flood-resistant buildings to protect against rising sea levels and storm surges (Aerts et al., 2014).

Green infrastructure is also gaining attention as a strategy for building urban resilience. Green infrastructure refers to natural or semi-natural systems that provide ecosystem services, such as stormwater management, temperature regulation, and air quality improvement. Examples of green infrastructure include green roofs, urban forests, wetlands, and permeable surfaces that absorb rainwater and reduce the risk of flooding. These systems not only enhance urban resilience to climate impacts but also provide co-benefits such as improved biodiversity and public health (Gill et al., 2007).

Another key aspect of resilient infrastructure development is the concept of "future-proofing." Future-proofing involves designing infrastructure that can adapt to a range of future climate scenarios, rather than relying on historical climate data. This approach recognizes the uncertainty of future climate conditions and the need for flexible and adaptable infrastructure solutions. For example, transportation systems may be designed with redundancy, allowing for alternative routes or modes of transport in the event of climate disruptions (Hallegatte et al., 2011).

The financing of resilient infrastructure development is a significant challenge for cities, particularly in low- and middle-income countries. While the costs of inaction are high, securing the necessary funding for large-scale infrastructure projects can be difficult. Innovative financing mechanisms, such as public-private partnerships, climate bonds, and international climate finance, are being explored as ways to mobilize the required resources (Bisaro & Hinkel, 2018).

Overall, resilient infrastructure development is a cornerstone of urban climate adaptation. It requires a combination of traditional engineering solutions, innovative green infrastructure, and forward-thinking design that anticipates future climate risks.

2.3. Community-based adaptation

Community-based adaptation (CBA) is an approach that emphasizes the role of local communities in designing and implementing climate adaptation strategies. CBA recognizes that communities possess valuable knowledge about local environmental conditions and vulnerabilities, and that they should play a central role in adaptation planning.

One of the strengths of CBA is its focus on local knowledge and participation. Traditional top-down approaches to climate adaptation often overlook the specific needs and priorities of local communities, particularly marginalized groups. In contrast, CBA involves communities in the decision-making process, ensuring that adaptation measures are relevant, culturally appropriate, and effective in addressing local risks (Reid & Huq, 2009). This participatory approach also helps to build community ownership and commitment to adaptation initiatives, which is critical for their long-term success.

CBA strategies often include a combination of traditional practices and new technologies. For example, in rural areas, communities may revive traditional agricultural practices that are well-suited to local climate conditions, such as drought-resistant crops or water-saving irrigation techniques. At the same time, they may adopt new technologies, such as climate-resistant seeds or early warning systems for extreme weather events (Ensor & Berger, 2009).

Another key element of CBA is social capital, which refers to the networks, relationships, and trust within a community. Social capital can enhance a community's resilience by facilitating collective action, sharing resources, and providing support during times of crisis. For instance, communities with strong social networks are often better able to organize evacuation plans, distribute relief supplies, and rebuild after a disaster (Pelling & High, 2005).

However, CBA also faces challenges. One of the main challenges is scaling up local initiatives to have broader impacts. While community-based projects can be highly effective at the local level, they may not always be sufficient to address the larger-scale drivers of climate vulnerability, such as economic inequality or environmental degradation. Therefore, CBA must be integrated into broader policy frameworks and supported by higher levels of government (Dodman & Mitlin, 2013).

Additionally, CBA must navigate the complexities of power dynamics within communities. Not all members of a community are equally vulnerable to climate impacts, and not all have the same capacity to participate in adaptation planning. CBA initiatives must be sensitive to these dynamics and ensure that the voices of the most vulnerable are heard and that their needs are prioritized (Satterthwaite et al., 2020).

In conclusion, community-based adaptation is a crucial component of urban climate change adaptation. It empowers communities to take action, leverages local knowledge and social capital, and ensures that adaptation strategies are responsive to local needs. However, it must be supported by broader policy frameworks and be inclusive of all community members to be truly effective.

3. Methods

This study adopted a qualitative approach to explore the intricate relationship between urbanization and climate change in Vietnam, with a focus on governance and policy responses, infrastructure development and resilience, and community-based adaptation as key tools for mitigating and adapting to the adverse effects of climate change. The research aimed to understand how these elements interact within the urban context, particularly in cities that are highly vulnerable to climate-related disasters.

A comprehensive literature review was conducted as the foundational step of this research. Various academic sources, including books, journal articles, and reports, were meticulously analyzed to provide a thorough understanding of urbanization and climate change dynamics in Vietnam. The review focused on identifying the theoretical and conceptual frameworks that link urbanization to climate change, especially within the context of disaster risk reduction and resilience building. The literature review also sought to contextualize these frameworks within the specific socio-economic and environmental conditions prevalent in Vietnam, providing a basis for subsequent analysis.

The study employed a case study methodology to delve deeper into specific instances of urban climate change adaptation in Vietnam. Two cities were selected as case studies:

- Da Nang City: Integrating Green Infrastructure. This case study examines Da Nang's approach to incorporating green infrastructure as part of its urban planning strategy to enhance climate resilience.
- Ho Chi Minh City: Managing Urban Flood Risks. The second case study explores the measures taken by Ho Chi Minh City to manage urban flood risks, which are exacerbated by rapid urbanization and climate change.

These case studies were selected based on their relevance to the research objectives and their potential to illustrate the diverse ways in which urban areas in Vietnam are adapting to climate change.

The research methodology adopted in this study provides a robust framework for understanding the interplay between urbanization and climate change in Vietnam. By combining a thorough literature review with detailed case study analysis, the study offers insights into the effectiveness of various adaptation strategies and the role of governance, infrastructure, and community-based approaches in building urban resilience. The findings are expected to inform policy development and implementation aimed at mitigating the impacts of climate change in rapidly urbanizing areas of Vietnam.

4. Results

4.1. Urbanization and climate change in Vietnam

4.1.1. Rapid urbanization

Vietnam's urban population has grown significantly over the past few decades, with urbanization rates reaching over 38% in 2023, up from 19.5% in 1986 (GSO, 2023). This rapid urbanization has led to the expansion of cities into vulnerable areas, particularly along the coast, where the risk of climate-related disasters such as typhoons, storm surges, and flooding is high.

4.1.2. Climate change vulnerabilities

Vietnam is one of the most climate-vulnerable countries in the world, particularly due to its long coastline and significant population living in low-elevation coastal zones (IPCC, 2014). The central coastal provinces, where cities like Da Nang and Hue are located, are particularly at risk. These cities face a combination of sea-level rise, increased frequency of typhoons, and more intense rainfall, leading to severe flooding and coastal erosion.

4.2. Governance and policy responses

4.2.1. National policies on climate change adaptation

Vietnam has developed several national policies to address climate change, including the National Strategy on Climate Change (2011) and the National Target Program to Respond to Climate Change (NTP-RCC) (2016-2020). These policies aim to integrate climate change adaptation into socio-economic development plans, with a focus on building resilient infrastructure, protecting vulnerable populations, and promoting sustainable urban development (Government of Vietnam, 2011).

4.2.2. Urban governance challenges

Despite these efforts, urban governance in Vietnam faces significant challenges in effectively implementing climate change adaptation strategies. These include limited financial resources, lack of coordination between different levels of government, and insufficient technical capacity at the local level

(Strauch et al., 2018). Additionally, the rapid pace of urbanization often outstrips the ability of local governments to plan and implement adaptation measures, leading to increased vulnerability in urban areas.

4.3. Infrastructure development and resilience

4.3.1. Green infrastructure

Green infrastructure, including parks, wetlands, and permeable surfaces, plays a crucial role in urban climate change adaptation by reducing flood risks, mitigating urban heat islands, and enhancing biodiversity (Gill et al., 2007). In Vietnam, there has been growing recognition of the importance of integrating green infrastructure into urban planning. For example, the city of Da Nang has implemented various green infrastructure projects, including the restoration of rivers and lakes, to enhance urban resilience (People's Committee of Da Nang city, 2021).

4.3.2. Resilient housing

Housing is a critical aspect of urban resilience, particularly in areas prone to natural disasters. The Green Climate Fund (GCF) has supported the construction of resilient houses in Vietnam's central coastal provinces, designed to withstand storms and floods (GCF, 2022). These houses are built using local materials and traditional techniques, combined with modern engineering principles, to ensure they can endure extreme weather conditions. The success of these resilient housing projects highlights the importance of incorporating local knowledge and practices into adaptation strategies.

4.4. Community-based adaptation

4.4.1. Community participation

Community-based adaptation (CBA) is essential in Vietnam, where local communities are often the first to experience the impacts of climate change. CBA involves engaging communities in the planning and implementation of adaptation measures, ensuring that local knowledge and needs are taken into account (Reid et al., 2009). In cities like Ho Chi Minh City and Can Tho, community participation has been integral to the success of flood management and disaster preparedness initiatives.

4.4.2. Challenges to community-based adaptation

While CBA has shown promise, there are challenges to its widespread implementation in Vietnam. These include limited access to resources, lack of awareness and education about climate change, and the need for stronger institutional support to scale up successful initiatives (Shaw, 2006). Addressing these challenges will be crucial for enhancing the resilience of urban communities in Vietnam.

4.5. Case Studies

4.5.1. Da Nang City – Integrating green infrastructure for urban resilience

Da Nang, a coastal city in central Vietnam, has implemented green infrastructure solutions to enhance resilience to climate change impacts, such as storms, floods, and urban heat. The city has adopted sustainable urban planning practices to address environmental challenges and build adaptive capacity.

Green infrastructure and flood control: Da Nang has focused on integrating green spaces, permeable surfaces, and stormwater management systems to reduce flooding risks. Key initiatives include constructing urban parks and green belts, which act as natural buffers to absorb stormwater and mitigate surface runoff. These measures not only help manage flood risks but also enhance biodiversity and improve air quality in the city.

Urban planning and climate resilience: The city has also implemented policies that prioritize green infrastructure in urban development plans. For example, the "Da Nang Sustainable City Development Project" focuses on integrating ecological designs into public spaces and transportation systems. By incorporating natural elements, such as trees and green roofs, the city enhances its capacity to withstand extreme weather events, while promoting long-term sustainability (World Bank, 2022).

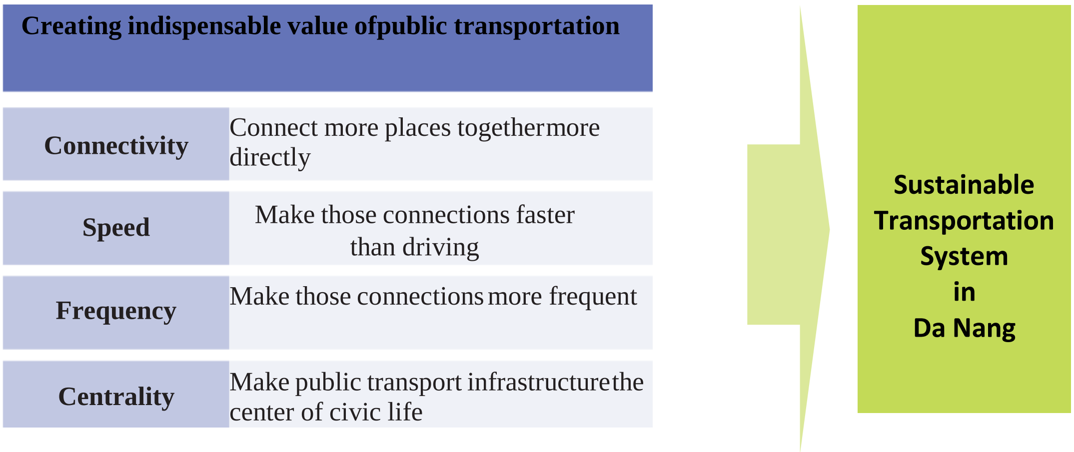

Figure 1: Creation of market value for public transportation in Da Nang City

Source: People's Committee of Da Nang city

Community engagement: Da Nang's success in integrating green infrastructure is also attributed to strong community involvement. Public awareness campaigns and stakeholder participation in decision-making have encouraged the adoption of sustainable practices. This bottom-up approach has been instrumental in ensuring the maintenance and effective utilization of green spaces.

These efforts have made Da Nang a model for other Vietnamese cities seeking to build urban resilience through green infrastructure.

4.5.2. Ho Chi Minh City – Managing urban flood risks

Ho Chi Minh City (HCMC), Vietnam's largest metropolis, faces significant flood risks due to rapid urbanization, low-lying topography, and increasing rainfall intensity caused by climate change. The city's adaptation strategy focuses on both hard and soft measures to manage these urban flood risks (World Bank, 2020).

Flood control infrastructure: HCMC has invested heavily in infrastructure projects, such as floodgates, levees, and drainage systems. A significant initiative is the city's multi-billion-dollar "Ring Dike System," designed to prevent tidal flooding. This system, combined with underground drainage networks, aims to protect the city from rising sea levels and seasonal storms. However, the effectiveness of these measures is often limited by insufficient capacity and maintenance challenges (Vachaud et al., 2019).

Soft adaptation measures: In addition to hard infrastructure, HCMC has embraced nature-based solutions and improved urban planning. One example is the preservation and restoration of mangrove forests in Can Gio, an area to the south of the city. Mangroves act as natural barriers, reducing storm surges and providing ecological benefits. The city also plans to expand green spaces to enhance water retention and reduce surface runoff, contributing to flood mitigation.

Challenges and opportunities: Despite these efforts, HCMC still faces challenges in addressing flood risks. Rapid urbanization, poor land-use planning, and inadequate drainage systems often exacerbate the problem. However, recent initiatives focusing on climate-resilient urban planning, such as revising building codes and enhancing the capacity of local authorities to implement flood management policies, offer hope for more sustainable flood risk management in the future.

Table 1: Effects of flooding on future land use in HCMC under 2050 extreme event

Future land use type	% future land use affected without flood control system	% future land use affected with flood control system
Urban	61	49
Industrial	67	63
Open space	77	76

Source: People's Committee of Ho Chi Minh city

These cases highlight the importance of integrating both green infrastructure and traditional engineering solutions in urban climate adaptation strategies. While Da Nang has focused on natural systems, HCMC combines large-scale infrastructure with ecological restoration to manage urban flood risks.

5. Conclusion and Recommendations

5.1. Conclusion

Vietnam's ongoing efforts to adapt its urban areas to the challenges of climate change are critical in addressing the country's vulnerability to rising sea levels, increasing temperatures, and more frequent extreme weather events. Through the case studies of Da Nang and Ho Chi Minh City, this paper has highlighted both the successes and limitations of current adaptation strategies. Da Nang's integration of green infrastructure demonstrates the potential for nature-based solutions to enhance urban resilience, while Ho Chi Minh City's approach to managing flood risks underscores the complexity of protecting rapidly urbanizing areas from climate impacts. However, both cities face challenges related to resource constraints, governance coordination, and community engagement, which hinder the full potential of these strategies.

Overall, Vietnam's urban climate change adaptation efforts have made important strides in policy development and infrastructure investment. However, the rapid pace of urbanization, combined with the growing intensity of climate impacts, requires a more integrated, inclusive, and long-term approach to adaptation planning. Addressing these challenges will be essential to building climate-resilient cities that can safeguard the well-being of Vietnam's urban population.

5.2. Recommendations

- Strengthen Policy and Institutional Coordination: A more integrated policy framework at both national and local levels is essential to streamline efforts between different government agencies and stakeholders. This includes enhancing coordination between climate change adaptation, urban planning, and disaster risk management sectors.
- Increase Investment in Green Infrastructure: Expanding the use of green infrastructure, as demonstrated in Da Nang, should be prioritized in other urban areas. Nature-based solutions can offer cost-effective, sustainable approaches to climate adaptation, while also providing additional social and environmental benefits.
- Enhance Community Engagement: Local communities play a critical role in building adaptive capacity. Efforts should be made to better integrate community input into adaptation planning and to provide resources and education to empower residents to take proactive measures in protecting their neighborhoods.
- Promote Climate-Resilient Urban Development: Urban planning in Vietnam's cities needs to account for long-term climate projections. This includes implementing building codes and zoning regulations that promote climate-resilient construction and infrastructure, particularly in flood-prone areas such as Ho Chi Minh City.
- Improve Data Collection and Monitoring: To support evidence-based decision-making, Vietnam must invest in the development of climate risk data and monitoring systems. This will allow for more precise identification of vulnerable areas and enable timely responses to emerging climate threats.

By addressing these recommendations, Vietnam can strengthen its capacity to adapt to the growing risks posed by climate change, ensuring the resilience and sustainability of its urban centers for future generations.

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Forestry Land Use in the context of Climate Change in Vietnam

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Abstract

Vietnam is considered one of the countries heavily affected by climate change due to its long coastline. The impact of climate change in Vietnam is very serious, posing an existential threat to the goals of poverty reduction, the millennium goals, and sustainable development. In this article, the author presents the current status of forestry land use in our country over the past time, the impact of climate change on the process of using forestry land such as the risk of degradation, fading, and pollution unprecedented due to unsustainable human production and economic development activities, deforestation, and the effects of climate change, leading to many areas of land being decertified. With that impact, forestry production, in particular, and the entire forestry industry in general, will shoulder a very heavy role, both ensuring development goals and serving as a biosphere reserve for human development. At the same time, the article proposes some solutions to cope with the impact of climate change on forestry land use in the coming time.

Keywords: *Climate change, land use, forestry land*

1. Introduction

Vietnam has nearly 15.4 million hectares of forestry land, of which over 13 million hectares are forested land. Although the forest cover area continues to increase, the quality of natural forests is decreasing. In addition to human impacts on forest quality, the complex changes in the global weather system have been increasing the extremes of weather. Complex fluctuations in weather can cause many different consequences. Climate change will lead to the risk of deforestation, conversion of forest land use purposes, threats to forest biodiversity, changes in species composition, distribution and growth ability of forest species. Ecosystems will be degraded, especially coastal ecosystems and mountain ecosystems. Desertification processes seriously degrade soil quality, rising sea levels, increased natural disasters, storms and floods will increase the phenomenon of salinity, waterlogging, riverbank and coastal erosion... leading to serious impacts. Paying attention to land and forestry resources, the reduced humidity index causes biomass decline in most types of forests, especially production forests (ADC, 2013; Nguyen et al., 2010).

2. Methods

The research was conducted based on the following methods: (1) relevant recent research results conducted by research centers, agencies, and organizations. Reports, statistical yearbooks, plans, resolutions, policies. Documents, economic statistics, a number of relevant analysis tables, and documents available at central and local agencies; theses, dissertations, magazines... as a basis for analyzing the current status of forestry land use in Vietnam in recent times; (2) interviewing experts: this method is used to collect additional opinions of experts in the field of forestry land in order to draw scientific arguments to serve the assessment and evaluation of the current situation status of forestry land use, effects of climate change on forestry land use, bases to add to response solutions.

3. Results

3.1. Current status of forestry land use in Vietnam

In the period 2019-2022, the structure of 3 types of forests will change towards a slight increase. That change is not the land growing on its own, but the increase in forest land area mainly comes from the increase in production forest land and protective forest due to the increase in planted forest land area, while the area of forest land increases. Special-use forest land has decreased due to deforestation.

Table 1: Changes in forestry land area 2019 - 2022 (ha)

Type land	Acreage 2022 (December 31, 2022)	Acreage inventory year 2019 (December 31, 2019)	Acreage statistical 2021 (December 31, 2021)	Compare area by year2022 with	
				Inventory year 2019	Statistical year 2021
Forestry Land	***15.467.573***	***15.381.113***	***15.439.656***	**86.460**	***27.917***
Production forest land	8.025.301	7.975.105	8.004.257	50.196	21.045
Protective forest land	5.123.200	5.111.918	5.112.054	11.282	11.147
Special-use forest land	2.319.072	2.294.090	2.323.346	24.982	-4.274

Source: Ministry of Natural Resources and Environment 2023

By 2022, the country's forestry land area will be 15,467,573 hectares, compared to the 2019 inventory area, an increase of 86,460 hectares, compared to 2021, an increase of 27,917 hectares, of which: Production forest land increased (21,045 hectares), Protection forest land increased (11,147 hectares), special-use forest land decreased (4,274 hectares). The reason for the increase in area is: Updating the current status according to measurement results; due to planting and developing macadamia trees in combination with some other forestry trees; due to reviewing and redefining land types in the planning of three types of forests in some provinces. Forestry land increased in the following provinces: Lao Cai (15,404 hectares), Gia Lai (6,422 hectares), Ha Giang (2,192 hectares), Lai Chau (2,166 hectares), Dak Nong (1,544 hectares).

The total natural area of the country in 2022 is 33,134,482 hectares, of which the structure and area of main land types are indicated in Figure 1.

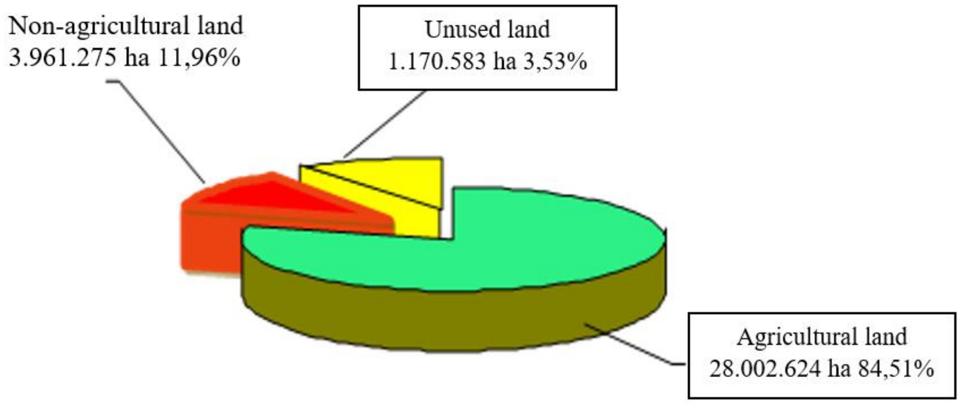

Figure 1: Land use structure of Vietnam 2022 (ha)

Source: Ministry of Natural Resources and Environment, 2023

Agricultural land group: has an area of 28,002,624 hectares, accounting for 84.51% of the total natural area, of which:

- Agricultural land: has an area of 11,673,421 hectares, accounting for 41.69% of the total agricultural land area.
- Forestry land has an area of 15,467,573 hectares, accounting for 55.24% of the total agricultural land area (including 8,025,301 hectares of production forest land, 5,123,200 hectares of protective forest land, 2,319 hectares of special-use forest land. 072 hectares).
- Aquaculture land: has an area of 784,000 hectares, accounting for 2.80% of the total agricultural land area;
- Salt production land: has an area of 15,374 hectares, accounting for 0.05% of the total agricultural land area;

- Other agricultural land: has an area of 62,256 hectares, accounting for 0.22% of the total agricultural land area.

Vietnam's forestry land accounts for a very large area of the total available land area. If calculated according to the actual production land structure, forestry land area accounts for a larger proportion than agricultural production land, this is an extremely huge resource, if exploited and used properly, will play a very important role in the socio-economic development process of localities with forestry land and of the whole country. In the current climate change conditions, correct and effective use of forestry land can also reduce the negative impacts caused by climate change.

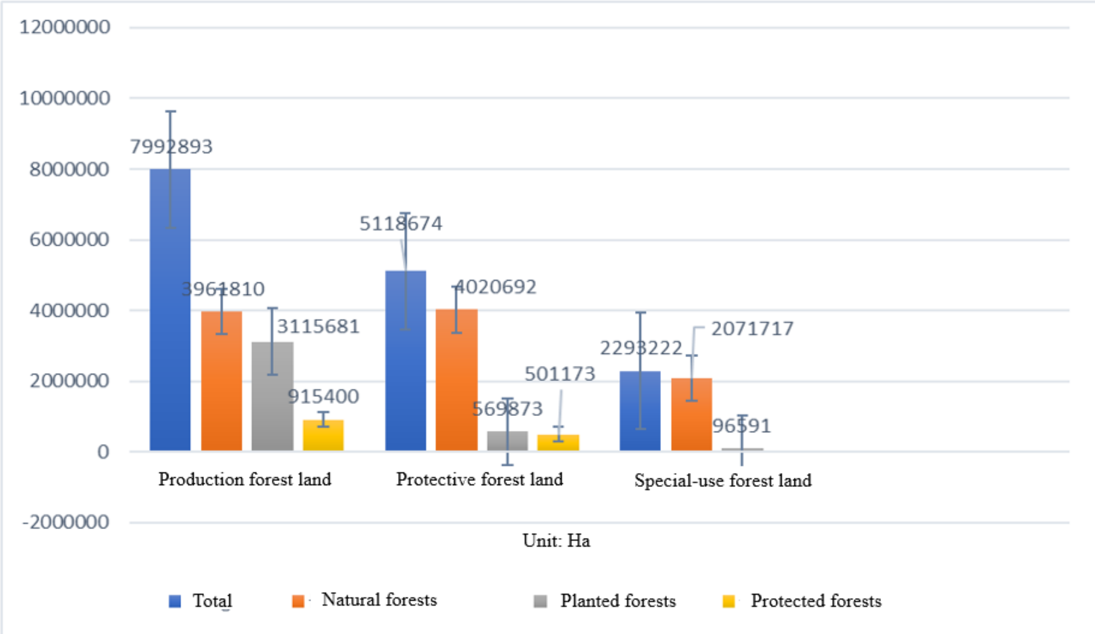

Figure 2: Forestry land area divided by current use status as of December 31, 2020

Source: Ministry of Natural Resources and Environment 2022

Data shows that the area of forestry land divided into three types of forest land in use today, land with natural forests is very large. This is truly a valuable capital of the forestry industry in particular and Vietnam in general, because currently, land with natural forests is bringing in income from forest environmental protection services that the world recognizes, therefore It is necessary to have a strict management strategy to protect natural forest areas on all three types of forestry land (GSO, 2022).

3.2. The impact of climate change on forestry land use

In fact, climate change is one of the most important factors that greatly affects the process of using forestry land. Climate directly affects forestry land through rainfall and temperature; indirectly through organisms. Climate change disrupts the rainfall regime, increases the risk of heat waves... causing higher loss of nutrients in the soil, more erosion and drought. Rising sea levels, natural disasters, and increased storms and floods will increase salinity, flooding, landslides on river banks and coasts... leading to serious impacts on forestry land resources.

Vietnam is considered one of the countries heavily affected by climate change due to its long coastline. If sea level rises 1 meter, 40% of the Mekong Delta area and 10% of the Red River Delta area will be flooded, directly affecting 20-30 million people. The impact of climate change on Vietnam is very serious, an existential risk to the goals of poverty reduction, millennium goals and sustainable development. According to the Intergovernmental Panel on Climate Change, when sea level rises by 1 meter, it is estimated that 5.3% of natural area, 10.8% of population, 10.2% of GDP, and 10.9% of urban areas will be affected, 7.2% of agricultural area and 28.9% of lowland areas in Vietnam will be affected. Under the impact of climate change, in just the last 10 years, natural disasters such as storms, floods, landslides, inundation, drought, saltwater intrusion... have caused significant damage, death and

More than 9,500 people were missed, property damage was estimated at 1.5% of GDP/year. In recent years, research on the effects of climate change has also pointed out many issues that need attention, for example, 2017 was the year with an unusually high number of storms affecting our country (16 storms), according to calculations by the Central Steering Committee for Natural Disaster Prevention and Control and the General Statistics Office, the damage was about 38.7 trillion VND, equivalent to 2.7 billion USD (Trieu, V. H., *et al*, 2020) The effects of climate change also impact livestock, forestry, biodiversity, forest fires, wetland ecosystems, aquaculture...

Impact on forest fire risk: In recent years, although the forest area in Vietnam has increased, forest quality has tended to decline. Only about 7% of primary forests remain, while poor secondary forests account for nearly 70% of the total forest area in the country. This is a type of forest that is very prone to fire. Over the past few decades, on average each year, Vietnam has lost ten thousand hectares of forest, of which, forest loss due to forest fires is about 16,000 hectares/year. Rising temperatures and severe, prolonged drought increase the risk of fire for all types of forests. Vietnam has about 6 million hectares of fire-prone forests, including pine forests, melaleuca forests, bamboo forests, eucalyptus forests, dipterocarp forests, young forests zoned for natural regeneration and specialty forests, ... In the context of climate change, as temperatures increase, droughts tend to increase in both frequency and intensity, so the potential risk of forest fires and large fires becomes more and more serious (Trieu et al., 2020).

Impact on the risk of development and spread of forest pests and diseases: Increased temperature, high humidity, heavy rain, strong winds, degraded land,... create favorable conditions for pests and insects. Damage to forests grows, develops and spreads into a very dangerous epidemic, destroying many large forests and seriously affecting the conservation and development of forest ecosystems in Vietnam, especially planted forests. Climate change creates conditions for more pest outbreaks in the Northeast, Northwest, South Central, and Central Highlands regions. The risk of pine caterpillars will increase compared to 2000, about 13% by 2050 and especially by 2100, the risk of developing pine caterpillars will increase by about 31%; Pine tree borers are more likely to have outbreaks in the Northeast, Northwest, South Central, Central Highlands, and Southeast regions; Bamboo locust outbreaks are the most likely to occur in the Southeast and Southwest regions; Mosquito bugs are the most likely to spread epidemics in the Northern Delta, South Central, and Central Highlands; Termite outbreaks are likely to occur in most regions (MONRE, 2019).

Climate change will change the structure of crops and crops, reducing forest growth. Leading to the risk of deforestation and conversion of forest land use purposes. Climate change threatens to the forest biodiversity, changer the species composition, distribution and growth ability of forest creatures. The area of deciduous (oil family) and semi-deciduous trees with many drought-resistant tree species will increase. Many tropical species that prefer light will become more migratory and subtropical species will gradually disappear. The number of populations of rare species will be depleted and the risk of harmful alien species will increase. Many species have to migrate to find new places to live and if they cannot adapt to new living conditions or compete with other species, they will forever disappear from the planet. Climate change increases the risk of epidemics and forest fires. Ecosystems will be degraded, especially coastal ecosystems and mountain ecosystems. Desertification processes seriously degrade soil quality and reduce wetness index, causing biomass decline in most types of forests, especially production forests. The population of rare forest animals and plants has decreased to the point of depletion, leading to the risk of extinction (MONRE, 2022).

Climate change and resource depletion will cause more than 50% of the global population to suffer from persistent water shortages by 2030, species diversity will have decreased by 10% by 2050, and old-growth forests will be reduced by 13% globally bridge; Greenhouse gas emissions increase by 50% and global temperatures may increase by 30–60 degrees Celsius by 2050, increasing the risk of forest fires and epidemics spreading; Bioenergy will thrive in response to the need to fulfill commitments to respond to climate change. The world and domestic carbon markets will grow rapidly and operate on a large scale with the support of science and technology that reduces the costs of measurement, appraisal and trade transactions. By 2030, the world population could reach 9 billion people, with urban residents accounting for 60% and the middle class growing; The need for a green, clean, beautiful living environment to improve human health is increasing, promoting and enhancing the role of the forestry industry in ensuring social security, healthcare and recreation, and the living environment (Nguyen, V. T., *et al*., 2010). With that impact, forestry production in particular and the entire forestry industry in general will shoulder a very heavy role, both ensuring development goals and serving as a biosphere reserve for human development. Those impacts lead to disturbance of forest and forestry land areas, so this is one of the most important factors affecting the future use of forestry land (MONRE, 2020). Thus, it can be seen that climate change causes the forest land area to shrink, which is one of the factors that greatly affects the process of using forest land in the near future.

3.3. Solutions to cope with the impact of climate change on forestry land use

Based on the experience of countries that have implemented national plans and practices in Vietnam, a number of solution groups can be proposed as follows:

Orientation: Documents of the 13th Party Congress clearly indicate that in the coming time we need to: Proactively and effectively adapt to climate change, prevent, combat and mitigate natural disasters and epidemics; manage, exploit, and use resources reasonably, economically, effectively, and sustainably; protect the living environment and people's health as the top goals; Resolutely eliminate projects that pollute the environment, ensure the quality of the living environment, and protect biodiversity and ecosystems; build a green, circular and environmentally friendly economy.

The key tasks during the term of the 13th Party Congress on resource management and environmental protection are Strict management, reasonable and effective use of land and resources, protection and improve the environment, and proactively and actively deploying solutions to adapt to climate change.

Strategy and policies: To use forestry land in accordance with new development conditions and contexts, improve institutions and policies on forestry land management and use in a synchronous and appropriate manner. The mechanism for developing a socialist-oriented market economy must be given top priority. From there, new forestry land resources are managed, exploited and used to ensure the most economical, sustainable and effective use; meet the requirements of promoting industrialization, modernization, fairness and social stability; ensure national defense and security; environmental protection, adaptation to climate change; create motivation for our country to become a developed country with high income. Reviewing the current legal system and policies, assessing the level of attention to climate change factors in the State's legal documents and land policies, thereby determining which documents promulgated, need to be amended and supplemented to enhance the responsibility of sectors and levels. Developing, supplementing and completing the system of legal documents on land which are related to the climate change adaptation and mitigation and other related policy mechanisms.

Integrating climate change factors into forestry land use strategies, master plans and plans: is the action of reviewing, adjusting and supplementing those strategies, master plans and plans, including topics such as: policies, mechanisms and organizations related to the implementation of strategies, planning and plans, tasks and products as well as means and conditions for implementation in accordance with changing trends climate, extreme climate phenomena and their immediate and long-term impacts on forestry land resources.

Forestry land use planning: National plans as well as land use plans and plans for sectors and fields that use land must ensure suitability, consistency, synchronization, and close connection, promoting each other to develop. Land use planning and plans are established at the national, provincial and district levels, meet the requirements of implementing the Strategy for rapid and sustainable socio-economic development; ensure national defense and security; protect the environment, adapt to climate change. The determination of land use criteria must be consistent with land use needs, avoid waste in land allocation, management and use. Clearly and strictly regulate the approval and promulgation of annual land use plans. The State must ensure sufficient resources to prepare land use planning and plans for sectors and fields that use forestry land.

Forestry land management and use to reduce greenhouse gas emissions: Protect and preserve existing forestry land areas, expand forestry land areas... to promote the implementation of programs to conserve and enhance greenhouse gas absorbers. Ensure protection, development and sustainable use of 16.24 million hectares of land planned for forestry; Develop a program to effectively use vacant land and bare hills to create jobs for workers and eliminate hunger and reduce poverty; Apply land use models that have the potential to reduce or eliminate greenhouse gas emissions; Mountainous and highland areas are frequently affected by climatic phenomena, such as heavy rains, flash floods, landslides, hot dry weather and drought. This phenomenon tends to occur more strongly due to the effects of climate change. Therefore, the orientation of forestry land use in this area needs to focus on promoting intensive farming in places with irrigation and drainage capabilities; Strengthen agroforestry, most appropriately exploit forestry land resources in the direction of commodity production; Protect, maintain and develop vegetation in watershed areas, high mountain areas, and protective areas.

Propaganda and dissemination of land law in general and legal regulations on forestry land use: In the current context of climate change, propaganda and education work to raise awareness of the whole society about the role and importance of forests and forestry land, the value of biodiversity and the significance of preserving rare genetic resources; change the practice of using products derived from wild animals and plants; conserve and develop forest resources and PFES values for sustainable development, ensuring national defense and environmental security of the country; Raise awareness of sectors, levels and people about the rights, obligations and social responsibilities of relevant parties for forest protection, in the context of international integration and response to change climate. Another important measure is to raise community awareness and capacity for managers, policy makers... on climate and climate change to land resources in Vietnam to have the way to adapt to climate change.

International cooperation: Develop a land management and use plan to respond to climate change, a list of programs and projects in the field of climate change to land resources in Vietnam to call for funding. Support and receive technology transfer from developed countries.

4. Conclusion

The unsustainable development of forests and forestry has contributed to increasing the extremes of Vietnam's climate and weather. Low forest cover and poor forest quality have also contributed to reducing the ability to absorb greenhouse gases emitted from other production sectors, affecting the climate and weather, increasing the frequency of natural disasters such as storms, floods, droughts, causing severe cold, high tides, increasing temperatures and rising sea levels, causing high tides and widespread salinity and acidification. Thus, it can be seen that climate change causes the area of forestry land to shrink, which is one of the factors that greatly affects the use of forestry land in the near future. Recognizing the role and importance of forestry land use in production and human life, in order to effectively respond and minimize the damage of climate change, it is necessary to propose feasible solutions to effectively respond to climate change to ensure sustainable development.

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Overview of Greenhouse Gas Reduction from Rice Land Use in Vietnam

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Abstract

The article outlines the theoretical and practical basis for reducing greenhouse gas emissions from rice land use in the world and Vietnam. In addition, it also proposes some solutions to enhance the reduction of greenhouse gas emissions from rice land use in Vietnam. Data related to greenhouse gas emissions from rice land use are collected from officially published research works and government policies. Greenhouse gases from rice land use mainly include CH_4, N_2O, and CO_2. They are the agents causing climate change and global warming. Scientists have studied and applied various measures to reduce them such as reducing nitrogen fertilizer, alternating flooding and drying according to each growth stage of rice, collecting rice by-products, not burning straw in rice fields, changing rice varieties and land preparation techniques, etc. Vietnam currently has about 3.9 million hectares of rice land. Rice production also emits large amounts of greenhouse gases. Vietnam has applied low greenhouse gas emission rice land use models in many localities, especially in the Mekong Delta. They have created clear effects. To achieve the goal of zero carbon emissions by 2050, it is necessary to synchronously implement solutions on policies, techniques, human resources, and finance in rice land use.

Keywords: *CH_4, N_2O, and CO_2, greenhouse gas emissions, rice land use, Vietnam*

1. Introduction

Rice is an important food crop and is being grown in 124 countries, including Vietnam. The global rice growing area in 2021 was 165.25 million hectares and has been increasing in recent years. From 2010 to 2021, the rice growing area increased by 3.55 million hectares (FAOSTAT, 2021). Vietnam's rice growing area is about 3.9 million hectares (accounting for 33.42% of the total agricultural land area). Using rice-growing land creates jobs and income for 3.8 million households and individuals (Ministry of Natural Resources and Environment, 2023). Vietnam is a self-sufficient country in food, mainly rice, and is also one of the largest rice exporters in the world. In 2023, it exported 28 million tons of rice (General Statistics Office, 2024). However, greenhouse gas emissions from rice land use play an important role in global warming and climate change (Z. Ahmed et al., 2022). Rice land use accounts for about 1.5% of global greenhouse gas emissions and 48% of total greenhouse gas emissions from cropland (FAOSTAT, 2021). Rice land use also consumes about 40% of global freshwater resources and has low water use efficiency (Islam et al., 2022; Kaur et al., 2024). Therefore, reducing greenhouse gas emissions from rice land use is an issue of interest to policymakers, managers, and scientists around the world in different aspects and levels of depth (Islam et al., 2022; Leon & Izumi, 2022; Luyen & Kamoshita, 2023; Narh et al., 2020). Many national leaders consider reducing greenhouse gas emissions as one of the top tasks in governing their countries (Gupta et al., 2021; Hasan, 2013). They have issued policies to encourage and support low-carbon production, including rice production (Pandey et al., 2014; Pramono et al., 2020; Zhang et al., 2024).

Scientists have studied the scientific basis of greenhouse gas emissions in land use, as well as the effectiveness of applying various measures in rice land use (Xia, 2023; Zhang et al., 2024). Some studies have examined the impact of reducing nitrogen fertilizer reducing irrigation water or reducing seed quantity on reducing carbon emissions (Trang & Trinh, 2024; Trinh et al., 2016; Wu et al., 2024). The issue of collecting and processing by-products from rice production has also been studied to limit their disposal in the fields or burning (Hao et al., 2023; Saha et al., 2022; Tho & Umetsu, 2022). This causes environmental pollution and CO2 emissions. Many authors have studied factors affecting greenhouse gas emission reduction, including the application of information technology in rice land use management, as well as rice harvesting and post-harvest processing (Papaskiri et al., 2021; Rajbonshi et al., 2024). However, to date, there has been no comprehensive study to synthesize theoretical and practical issues on greenhouse gas emission reduction from rice land use to have an overall view of this issue, including Vietnam. Therefore, our study aims to address this research gap. The purpose of the study is to answer the following questions:

Q1) What are greenhouse gas emissions from rice land use?

Q2) What is the current status of greenhouse gas emissions reduction from rice land use?

Q3) What solutions need to be implemented to enhance greenhouse gas emissions reduction from rice land use in Vietnam?

The structure of the article includes an overview of theoretical and practical issues related to greenhouse gas emissions from rice land use in the world, including Vietnam, and proposes some solutions to enhance its reduction in Vietnam.

2. Theoretical framework

2.1. Concept of greenhouse gas emissions from rice land use

Rice land according to the provisions of Vietnamese land law is land for growing one or more rice crops in a year (Ministry of Natural Resources and Environment, 2024). In some areas of Vietnam, farmers grow up to 3 rice crops in a year when the climate conditions are favorable. Normally, they grow one or 2 rice crops in a year on a field. In the remaining time, they grow other crops or leave the field fallow to restore soil quality.

According to research results of scientists, greenhouse gas emissions from rice land use mainly include CH_4, N_2O, and CO_2 (Padhi et al., 2024; Shen et al., 2021). In land used for rice cultivation, CH_4 is a product of the decomposition of organic matter by microorganisms under anaerobic conditions. Part of the CH_4 produced is oxidized by Methanotroths bacteria in the topsoil layer (1-3 mm thick) around the roots of plants, while the rest is released into the atmosphere mainly by diffusion through the plant's vascular system - the system that provides oxygen for respiration (Islam et al., 2022; Leon & Izumi, 2022; Narh et al., 2020).

Nitrous oxide (N_2O) in rice soil is produced by microorganisms, as a by-product of nitrification or an intermediate product of denitrification (Bouwman, 1990). Fertilized cropland is a significant source of N_2O emissions, accounting for 13% (Rajbonshi et al., 2024) to 28% (Suratno et al., 1998) of annual global N_2O emissions.

CO_2 is mainly produced from burning straw after rice harvest (Luyen & Kamoshita, 2023; Yen & Kamoshita, 2024). According to the Ministry of Natural Resources and Environment (2018), in Vietnam, carbon emissions from rice land use are 43.79 tons annually, accounting for 49.35% of the total emissions of the agricultural sector. Thus, CO_2 emissions from rice production account for a large proportion and need to be reduced along with N_2O and CH_4 reduction by various measures.

2.2. Measures to reduce greenhouse gas emissions from rice land use

According to scientists, the main factors causing greenhouse gas emissions in the rice production process are excessive nitrogen fertilizer application, straw burning or burying straw in the soil, or long-term flooding (Islam et al., 2022; Narh et al., 2020). To reduce greenhouse gas emissions, scientists have proposed solutions related to these factors. Technically, it is necessary to reduce the amount of seeds sown, reduce the amount of fertilizer, and reduce pesticides. Rice varieties must be certified or purebred as recommended by the agricultural sector and reduce the number of seeds sown, reduce fertilizer, reduce the use of pesticides, reduce the amount of irrigation water, and reduce post-harvest losses. Reducing the amount of nitrogen fertilizer means reducing the impact of greenhouse gas emissions (Leon & Izumi, 2022).

To reduce CO_2, it is necessary to limit straw burning. In addition, it is also necessary to limit the burying of straw in the soil because it emits methane. In particular, more mechanization is needed and effective calculations are needed, or re-burying in the soil requires solutions to limit emissions.

In the process of using rice land, it is necessary to implement the technique of "alternate flooding and drying". Alternate wetting and drying are called "controlled irrigation" or "multiple irrigations" around important growth stages of rice plants such as flowering. This helps control weeds and ensures that rice plants have enough water while reducing methane emissions from the rice land use system as well as the absorption of arsenic by rice plants, a substance that is very harmful to human health. Implementing water conservation will help increase the resistance of rice plants to pests, but to reduce greenhouse gas emissions, there must be very detailed solutions and the need to redesign the fields as well as train farmers and need to measure accurately to calculate the effectiveness of "alternate flooding and drying".

3. Methods

The study refers to published scientific research works related to greenhouse gas emissions from rice land use. In addition, the study also synthesizes the state's policies to reduce greenhouse gas emissions from rice land use. The study uses the method of analysis and comparison of policies and solutions to reduce greenhouse gas emissions from rice land use as a basis for proposing solutions to enhance its reduction in the coming time in Vietnam.

4. Results

4.1. Applying measures to reduce greenhouse gas emissions from rice land use in the world

In the Philippines, to implement the practice of alternating flooding and drying of rice fields, the government invested in building irrigation systems to optimize the use of irrigation water. Farmers were able to cultivate a larger area with a 16% increase in irrigated land area and some areas of the island, they were able to grow two rice crops per year instead of one. In addition, they also collected all the by-products from rice production in the fields and processed them for various purposes (Padhi et al., 2024). In India, greenhouse gas emissions from rice land use were reduced through cropping patterns, specifically, reducing the area of rice land for other crops. Policymakers and regulators have issued policies to support farmers in investing in irrigation systems and research to create new rice varieties that require less water during growth and in collecting and treating rice straws (Gupta et al., 2021). The Egyptian government encourages scientists to research solutions to reduce methane emissions from rice cultivation that can mitigate climate change. Special attention is also paid to straw management to combat methane and carbon emissions from burning rice residues in the fields. Proposed strategies to reduce methane emissions from rice cultivation include water management, fertilizer management, and short-term rice varieties. These mitigation strategies are evaluated in terms of their sustainable environmental impacts using a weighted composite approach. The study results showed farmers' acceptance or participation in applying different mitigation strategies and influencing the application of measures to reduce greenhouse gas emissions from rice land use (Hasan, 2013).

Bangladesh has also made great efforts to find solutions to limit greenhouse gas emissions from rice land use. However, the effectiveness of the measures is limited and uneven in localities due to different farmers' awareness and different natural conditions. The diversity of rice cultivation in terms of agro-climatic conditions and farming practices makes it difficult to make specific recommendations. Results in Bangladesh show that water and organic matter management are the most effective methods to reduce greenhouse gas emissions regardless of farming conditions.

In China, developing appropriate emission reduction strategies and estimating their potential are considered crucial to achieving low-carbon rice production. The use of water-saving and drought-tolerant rice with improved water and nitrogen use efficiency has created a low-GHG rice production system. Implementing a mitigation strategy, including direct seeding and dry cultivation, combined with a 53% reduction in nitrogen fertilizer application, can effectively reduce methane (CH_4) and nitrous oxide (N_2O) emissions from rice fields. Compared with conventional flooded rice cultivation, this integrated approach shows impressive potential to reduce net greenhouse gas emissions by 97% while doubling the economic benefits. When combined with plastic mulch, this strategy not only maintains rice yield but also achieves a significant emission reduction of 92%, resulting in a fourfold increase in economic benefits (Zhang et al., 2024).

4.2. Applying measures to reduce greenhouse gas emissions from rice land use in Vietnam

In Vietnam, many studies have also shown that continuous cultivation, high seed use, overuse of chemical fertilizers, and maintaining a constant water level in the fields are among the reasons for ineffective rice cultivation, low fertilizer efficiency, and increased greenhouse gas emissions. Regarding fertilizers alone, 2019 data show that on average, one hectare of rice uses more than 0.4 tons of fertilizer, a 10-fold increase compared to nearly 60 years ago (Trinh et al., 2016). In 2023, the Prime Minister of Vietnam issued a decision approving the Project on sustainable development of one million hectares of land specializing in high-quality rice cultivation and low greenhouse gas emissions in the Mekong Delta by 2030 (Prime Minister, 2023). The specific goal of the Project is to achieve 1 million hectares of high-quality rice by 2030 and reduce sowing to less than 70 kg/ha, reduce the use of chemical fertilizers and pesticides by 30%, and reduce the amount of water used. In addition, the post-harvest loss rate is less than 8%; 100% of straw in specialized areas is collected from the fields and processed for reuse; greenhouse gas emissions are reduced by more than 10% compared to traditional rice cultivation... The profit margin of farmers using rice land is over 50%.

Vietnam has piloted environmentally friendly rice land use models (reducing greenhouse gas emissions) in many localities. In Dak Lak province, it is implemented according to the green rice cultivation process to reduce emissions and increase productivity. This is a solution that combines the alternating wet and dry rice cultivation process with Nanocomposite preparations. This model helps rice production reduce dependence on chemical pesticides by up to 40%; increase productivity by 15 - 20%; change traditional farming methods, minimize environmental pollution, improve rice cultivation land, clean rice, etc. (Thanh Thao, 2024).

In Can Tho, a model of using rice land to reduce emissions is implemented on a pilot area of 50 hectares. The OM5451 rice variety is selected for sowing with a seed quantity of 60kg/ha. The field is applied with 3 sowing technologies: using a row seeder, a row seeder combined with normal fertilizer burying, and a row seeder with border effect combined with fertilizer burying. With the technology of row seeder with border effect combined with fertilizer burying, taking advantage of the light effect helps the rice plants to be healthy, giving higher yields. The technology of sowing in rows or clusters combined with burying fertilizer will reduce the number of fertilizer applications from 3-4 times/crop to 2 times/crop. This solution helps farmers reduce the amount of fertilizer by 20%. In addition, it also helps reduce the amount of irrigation water, disease risks, lodging, and post-harvest losses. Some advanced farming techniques include alternating wet and dry water management; applying specialized fertilization in specific areas; applying combine harvesters for harvesting, etc. Especially the technique of collecting straw from the field to grow mushrooms and fertilizer from straw, combined with organic fertilizer for rice (Khanh Trung, 2024).

Dong Thap applies a rice production model on an area of nearly 70,000 hectares, applying sparse sowing (from 60-70 kg/ha for rice varieties over 90 days and from 90-100 kg/crop for varieties under 90 days). Regarding fertilizer, the cooperative only applies a maximum of 200 kg/ha/crop for chemical fertilizers and from 300-500 kg/ha for organic fertilizers. This model reduces production costs by 30%, yields are equivalent to or higher than outside, and rice quality will be higher and sold at a higher price. The price is 30-40% higher than normal rice. During the production process, it is easy to remove straw from the field, and the stubble can be decomposed quickly with Trichoderma fungus to sow the new crop with high efficiency (Thuy Ly, 2024). Nghe An province has also applied alternating wet and dry irrigation rice cultivation, reducing emissions. In the spring crop of 2024, the project of alternating wet and dry irrigation has been implemented, reducing emissions on an area of nearly 6,000 hectares in 5 districts of the province. The results of the first crop showed that rice in the alternating wet and dry irrigation system grew well, tillered well, had fewer pests and diseases, and resisted lodging better. The yield in the alternating wet and dry irrigation project areas was equivalent to or higher than that of traditional flooding while reducing up to 3 times of water pumping/crop. The amount of CH_4 emitted was significantly reduced compared to traditional folded rice cultivation, and could be registered as carbon credits (Thanh Thao, 2024).

Vietnam has also converted land used for inefficient rice cultivation to other upland crops, contributing to reducing greenhouse gas emissions. Because the emissions in upland crops are low, converting land used for inefficient rice cultivation to upland crops will help reduce greenhouse gas emissions. In addition, localities also convert land from producing 2-3 rice crops to producing 1 rice crop and 1 crop of other crops. To achieve sustainable efficiency, localities must have established production plans and invested in renovating irrigation systems and processing facilities.

Techniques applied in rice land use include young rice seedlings, single-crop planting, sparse planting, water management, weeding, mud aeration, and organic fertilizer application. The effectiveness of these measures shows that the amount of seeds is reduced by 70-90%; the use of chemicals is reduced by 70-100%; irrigation water is saved; pests and diseases are reduced; rice plants are more resistant to lodging; rice yields are increased; production costs are reduced by an average of 342 to 520 VND/kg of rice (Anh Tuyet, 2023). Farmers have also gradually used straw to make handicrafts, fertilizers, mushrooms, and bio-beds in livestock farming. This also reduces CO_2 and CH_4 emissions from rice land use. Many farmers have replaced urea fertilizers with slow-release fertilizers, controlled-release fertilizers, and high-quality complex fertilizers, improving fertilizer use efficiency and reducing greenhouse gas emissions.

5. Conclusion and Implications

Greenhouse gas emissions from rice land use are one of the factors causing climate change and global warming. The main emissions from rice land use are CH_4, N_2O, and CO_2. They arise mainly due to excessive nitrogen fertilizer application, retaining water for too long in rice fields, burning straw, and burying straw in the fields without treatment. Countries around the world apply different measures based on their specific conditions. The main measures applied are minimizing urea fertilizer application, combining irrigation with drying rice fields suitable for the growth process of rice plants, using high-yield rice varieties that require less irrigation water, collecting and effectively treating rice by-products such as straw, etc.

Vietnam has also applied the above solutions to minimize greenhouse gas emissions from rice land use. However, the current use of rice land still has some limitations, so the effectiveness of greenhouse gas emission reduction is not as expected. Rice plots in many localities are still small and fragmented, making it difficult to apply mechanization and proactive irrigation for rice. The irrigation and intra-field transportation systems are not yet convenient for rice production and the collection and transportation of straw to warehouses for processing. Many farmers' awareness of reducing greenhouse gas emissions is still limited, so they still traditionally use rice land. In addition, the State's policies on financial support, rice seeds, fertilizers, and agricultural product processing are still limited. Some officials are not interested in applying measures to reduce greenhouse gas emissions from rice land use. In particular, their interest in circular economy and green economy in rice production is also limited. The level of inspection of the application of measures to reduce greenhouse gas emissions is still low.

To implement the Vietnamese Government's commitment to the international community to achieve zero carbon emissions by 2050, and to improve economic efficiency and ensure environmental sustainability in the use of rice land, we recommend: Strengthening propaganda and raising awareness among rice land users so that they can produce rice using environmentally friendly technology; The State needs to encourage people to accumulate and concentrate rice land to create plots of land with areas favorable for irrigation, mechanization, and reducing the amount of fertilizer, especially urea; Scientists also need to research and innovate rice cultivation methods and new rice varieties that are more drought-resistant and have higher yields; authorities at all levels and officials also need to pay more attention to applying measures to reduce greenhouse gas emissions in the process of using rice land. In particular, it is necessary to expand international cooperation and seek the assistance of international organizations in rice production to reduce greenhouse gas emissions.

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Enhancing Student Engagement and Leadership in Climate Action by Organizing Extracurricular Activities on Climate Change at the University Level

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Abstract

Climate change is one of the most pressing global challenges of our time, requiring urgent action at all levels of society. Universities, as centers of learning and innovation, play a crucial role in equipping students with the knowledge and skills needed to address climate change. While classroom learning provides theoretical foundations, extracurricular activities offer practical and hands-on experiences that are vital in fostering a deeper understanding of the subject. This paper examines the importance of integrating extracurricular activities related to climate change at the university level, with a particular focus on their role in enhancing students' environmental awareness, promoting interdisciplinary collaboration, and encouraging active participation in climate action. By analyzing existing research and conducting a survey of students involved in climate-related extracurricular activities, this paper outlines the potential impact of such initiatives on student engagement and the broader academic community.

Keywords: *Climate change, extracurricular activities, university education, environmental awareness, student engagement*

1. Introduction

Climate change has emerged as one of the most significant global challenges of the 21st century, posing severe threats to ecosystems, human health, economic stability, and the social fabric of communities. The increasing frequency and intensity of extreme weather events such as hurricanes, floods, droughts, and heatwaves are a stark reminder of the urgent need to address the causes and consequences of climate change. As international efforts to mitigate its effects continue, the role of education in raising awareness and empowering individuals to take meaningful action becomes increasingly important.

Universities, as centers of learning, innovation, and social development, have a unique responsibility to address climate change not only through research but also by preparing future leaders to tackle these challenges (Ecomena, 2021). Higher education institutions are well-positioned to foster the critical thinking, problem-solving, and interdisciplinary collaboration necessary to combat the climate crisis. However, it has become evident that formal classroom education alone is insufficient for equipping students with the practical skills and experiential knowledge required to respond effectively to this complex issue (Choudary, 2010). While lectures, textbooks, and theoretical models provide the intellectual foundation for understanding climate change, students also need opportunities to apply what they learn in real-world contexts, develop leadership skills, and collaborate across disciplines. This is where extracurricular activities can play a vital role (Jha, 2014; Ningrum, 2018). The objective of this research is to explore the role and necessity of organizing extracurricular activities focused on climate change at the university level. Specifically, this paper aims to demonstrate how such activities contribute to a more comprehensive and practical understanding of climate issues, promote student engagement in environmental advocacy, and foster the development of leadership skills that are essential for driving climate action. By examining current trends in university-based extracurricular programs related to climate change, this study seeks to highlight best practices, identify gaps, and propose strategies for integrating these initiatives more effectively into higher education curricula.

Moreover, this paper will present evidence from both qualitative and quantitative research that underscores the positive impact of extracurricular involvement on students' understanding of and commitment to addressing climate change. Through a survey of students and interviews with faculty members, the research will also provide insights into how universities can support and expand these programs to maximize their educational and social benefits.

2. Literature review

Over the past decade, several studies have explored the role of education in climate change awareness and action. Scholars like Panth et al. (2015) emphasize that while theoretical knowledge about climate change is essential, hands-on experiences are equally critical for fostering a deeper understanding and sense of responsibility among students. Brown and Smith argue that students who participate in activities such as environmental clubs, campus sustainability initiatives, or community outreach projects are more likely to develop the skills necessary for long-term climate action. Their work supports the notion that experiential learning enhances students' ability to connect abstract climate concepts to real-world applications.

However, there is a gap in the literature regarding the specific contribution of extracurricular activities to climate education at the university level. While there is general agreement on the importance of experiential learning, few studies have systematically examined the range of extracurricular opportunities available to students, the barriers to participation, and the measurable impact these activities have on students' attitudes and behaviors. For instance, Poyyamoli and Alexender (2014) found that students involved in environmental organizations often report a stronger commitment to sustainable practices, but the study did not provide sufficient data on how these activities influence students' academic performance, career choices, or long-term engagement in climate action.

Moreover, research by Panth et al. (2015) highlights the importance of interdisciplinary collaboration in addressing climate change, but their study primarily focuses on formal academic projects. There is limited research that explores how extracurricular activities can foster interdisciplinary approaches by bringing together students from different fields such as environmental science, economics, sociology, and political science to work collaboratively on climate-related initiatives. This research aims to fill these gaps by providing a detailed analysis of how extracurricular activities contribute to climate change education, and how universities can better support these programs to enhance their impact.

This study draws upon experiential learning theory, developed by educational theorist Rabia, as its theoretical foundation. According to Rabia (2010), experiential learning is a process through which knowledge is created through the transformation of experience. The theory is based on the idea that learning is most effective when it involves active participation in real-world experiences, which allows individuals to reflect on their actions, make adjustments, and apply their knowledge to new situations. In the context of climate change education, extracurricular activities offer students the opportunity to engage directly with environmental issues, experiment with solutions, and reflect on the outcomes of their actions (Sra, 2012).

Extracurricular activities, such as campus sustainability projects, environmental advocacy groups, and community outreach programs, align with Kolb's model by providing students with practical experiences that reinforce and expand upon the theoretical knowledge they acquire in the classroom. These activities encourage students to take initiative, work collaboratively with their peers, and develop problem-solving skills in a dynamic, real-world environment. By participating in these programs, students can deepen their understanding of climate change, explore innovative solutions, and gain the confidence needed to become active contributors to the global climate movement.

In summary, this research will examine how universities can leverage extracurricular activities to complement academic education on climate change. By fostering experiential learning opportunities, universities can equip students with the skills, knowledge, and motivation needed to address one of the most critical challenges of our time.

3. Methods

This research adopts a qualitative approach, combining a literature review with a survey of university students who have participated in climate-related extracurricular activities. The data was collected through semi-structured interviews with faculty members and student leaders, as well as a questionnaire distributed to a sample of 230 students from various disciplines. The aim of the data collection was to explore the types of extracurricular activities available, the level of student engagement, and the perceived impact of these activities on students' understanding of climate change.

4. Results

The survey results indicate that students who engage in climate-related extracurricular activities demonstrate a higher level of awareness and understanding of climate change compared to those who do not participate. These students reported that the hands-on nature of extracurricular activities, such as campus sustainability projects, environmental clubs, and climate advocacy groups, provided them with a practical understanding of climate issues that complemented their academic learning. Furthermore, students highlighted the importance of interdisciplinary collaboration in these activities, which allowed them to approach climate change from multiple perspectives, including science, economics, and policy.

Table 1: Summary of student survey questions

Questions	Yes (%)	No (%)
Are you aware of climate-related extracurricular activities on campus?	87	13
Do you participate in any climate-related extracurricular activities?	61	39
Has participation increased your understanding of climate change?	78	22

Source: Authors

In addition to student responses, interviews with faculty members revealed that extracurricular activities play a key role in reinforcing classroom learning. Many faculty members noted that students who are active in climate-related initiatives tend to be more engaged in discussions about sustainability and are more likely to pursue careers in environmental fields.

4.1. Positive impact on student knowledge and engagement

The primary finding of this research is that participation in extracurricular activities related to climate change significantly enhances student knowledge and engagement. Survey data from students involved in university-based climate action groups, sustainability initiatives, and environmental clubs revealed a marked improvement in their understanding of key climate change concepts. For example, over 87% of respondents reported that their participation in these activities deepened their knowledge of topics such as carbon footprints, renewable energy, climate mitigation strategies, and the socio-economic impacts of climate change.

The interviews with students further support these findings. Many participants noted that extracurricular activities allowed them to engage with climate change issues in ways that classroom education could not. One student remarked, "In class, we learn the theory, but in the environmental club, we get to apply that knowledge. We organize events, campaign for change, and work with local communities, which makes the learning real and impactful." This sentiment was echoed by several others, emphasizing the hands-on nature of extracurricular activities and the experiential learning opportunities they offer.

Moreover, students highlighted that these activities fostered a sense of personal responsibility and urgency regarding climate change. While classroom education tends to be more passive, extracurricular involvement encouraged students to take action. For instance, participation in campus-wide sustainability projects, such as waste reduction campaigns or tree planting initiatives, motivated students to make eco-friendly choices in their daily lives. Many respondents reported that they started adopting sustainable practices, such as reducing energy consumption, recycling, and using public transportation, as a direct result of their involvement in extracurricular programs.

The data also showed that students who participated in extracurricular climate activities were more likely to engage in environmental advocacy outside of university settings. Around 70% of survey respondents indicated that they had become more active in climate advocacy, either by joining local environmental organizations or by participating in climate protests and lobbying efforts. This demonstrates the role of extracurricular activities in fostering a long-term commitment to environmental stewardship among university students.

4.2. Development of leadership and interdisciplinary collaboration skills

Another significant result of the research is the development of leadership and interdisciplinary collaboration skills among students involved in climate-focused extracurricular activities. The qualitative analysis of interview data revealed that these activities provided students with numerous opportunities to take on leadership roles, manage projects, and collaborate with peers from diverse academic disciplines. This is particularly important in the context of climate change, which requires solutions that span multiple fields, including environmental science, economics, sociology, and political science.

Several students shared that they gained valuable leadership experience by organizing campus events, leading sustainability campaigns, or coordinating community outreach programs. One student who served as the president of an environmental club explained, "Leading our climate action group has been one of the most rewarding experiences of my university life. It taught me how to work with a team, communicate effectively, and lead by example. These are skills that will be crucial for my future career, especially if I want to work in environmental policy."

Furthermore, many extracurricular activities provided opportunities for students to work with peers from other disciplines, enhancing their ability to collaborate across academic boundaries. For example, one university's "Green Campus Initiative" brought together students from environmental science, engineering, business, and sociology to work on sustainability projects. The program encouraged interdisciplinary collaboration by allowing students to apply their specific expertise to a common goal. Engineers worked on developing sustainable energy solutions, business students designed strategies for financing these initiatives, and sociologists studied the social impacts of the projects on the local community.

This interdisciplinary approach was highly valued by students, with many noting that it gave them a more holistic understanding of climate change. As one student put it, "Climate change is not just an environmental problem—it's a social, economic, and political one. Working with students from other departments helped me see the bigger picture and understand how different fields need to work together to create meaningful solutions."

4.3. Challenges in organizing and sustaining extracurricular activities

Despite the clear benefits of extracurricular activities for climate education, the research also identified several challenges that universities face in organizing and sustaining these programs. One of the main issues raised by students and faculty alike is the lack of institutional support. Many respondents reported that while there is a strong interest in climate-related extracurricular activities, universities often lack the necessary resources to support these initiatives effectively.

For instance, over 60% of survey respondents indicated that they had difficulty accessing funding for their projects. In some cases, students had to rely on external donations or fundraising efforts to finance their activities, which limited the scale and scope of their initiatives. One student shared, "We wanted to expand our waste reduction campaign to include more departments on campus, but we didn't have the budget to do so. It was frustrating because we had the support of the student body, but not enough resources to make it happen."

Similarly, faculty members who oversee or advise student-led environmental groups also pointed to the challenge of balancing extracurricular activities with their academic responsibilities. Many faculty members expressed that while they are passionate about supporting student climate initiatives, they often lack the time and resources to fully dedicate themselves to these activities. One faculty advisor explained, "It's a constant juggling act. I want to help my students develop their projects, but I also have research, teaching, and administrative duties that take up a lot of my time. There needs to be more institutional recognition of the importance of these activities so that faculty can get the support they need."

In addition to resource constraints, another challenge identified in the research is the inconsistent participation of students in extracurricular activities. Many students reported that while they are interested in climate change, academic pressures often prevent them from dedicating significant time to extracurricular activities. This was especially true during exam periods or when students had heavy coursework loads. One student remarked, “I love being part of the environmental club, but sometimes it’s hard to balance it with my studies. During finals, I have to prioritize my grades, which means I can’t always commit as much time to the club as I’d like.”

The data also suggested that universities with well-established extracurricular programs tend to have higher participation rates, as these programs often have more institutional support, visibility, and resources. In contrast, universities where climate-related activities are newer or less organized struggle to maintain consistent student involvement. This indicates that the success of extracurricular climate programs is closely tied to the level of institutional investment and support they receive.

5. Discussion and Conclusion

The findings of this research align with previous studies that highlight the importance of extracurricular activities in enhancing climate education. For instance, the work of Brown and Smith (2015), which emphasizes the role of experiential learning in climate education, is supported by the present study’s results. Both studies find that hands-on involvement in climate-related activities deepens students’ understanding of climate change and motivates them to take action.

However, the present research expands on previous studies by offering a more detailed analysis of the challenges associated with organizing and sustaining extracurricular activities. While earlier research has primarily focused on the benefits of these programs, this study provides a more comprehensive view by addressing the barriers that universities and students face, including resource constraints, inconsistent participation, and the need for greater institutional support.

Organizing extracurricular activities on climate change at the university level plays a crucial role in fostering environmental awareness, engagement, and leadership among students. These activities serve as a platform for practical learning, allowing students to connect theoretical knowledge from their academic curriculum with real-world applications. By engaging in climate-related projects, workshops, and campaigns, students develop a deeper understanding of the environmental challenges facing their communities and the world at large. This experiential learning not only enhances their knowledge but also encourages them to take personal responsibility for climate action, an essential step in addressing the global climate crisis. One of the key benefits of extracurricular activities is their ability to develop critical skills such as leadership, communication, and teamwork, which are vital for effective climate advocacy. When students collaborate in group projects, they learn how to work together towards common goals, negotiate solutions, and communicate their ideas effectively. These skills are not only valuable for their academic growth but also prepare them to become future leaders in sustainability efforts. Furthermore, by participating in climate-related initiatives, students are empowered to voice their concerns, engage with policymakers, and contribute to public discourse on climate change mitigation and adaptation.

Extracurricular activities also foster a sense of community and shared responsibility, helping to create a culture of environmental stewardship within the university. As students engage in climate change activities, they inspire their peers, faculty, and even the broader community to take part in sustainability efforts. This collective action can lead to significant institutional changes, such as the adoption of more sustainable campus practices, increased environmental education, and the integration of climate change topics into the broader curriculum. Universities, as influential institutions, can set an example by promoting sustainability and addressing climate issues through both formal and informal education channels. Moreover, these activities provide an avenue for interdisciplinary collaboration, bringing together students from various academic backgrounds to work on climate-related challenges. This diversity of perspectives fosters innovative solutions and encourages students to think critically about the complex, interconnected nature of climate issues. In doing so, universities not only contribute to the development of well-rounded individuals but also help advance climate solutions that consider social, economic, and environmental dimensions. Ultimately, by fostering awareness, skills, and action through extracurricular activities, universities can play a pivotal role in equipping the next generation with the tools they need to confront the pressing issue of climate change. These initiatives are essential for building a sustainable future and ensuring that students emerge as informed, active participants in the global effort to combat climate change.

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SECTION II

GREEN ECONOMY AND CIRCULAR ECONOMY

The Impact of Green Economic Policy on Sustainable Growth in Vietnam

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Abstract

This study examines the impact of green economic policies on sustainable growth in Vietnam, focusing on five key areas: renewable energy, resource management, green technology innovation, green finance, and sustainable agriculture. The research addresses the urgent need for balancing economic development with environmental sustainability in Vietnam's rapidly growing economy. Using a mixed-methods approach, the study collected data from 300 experts across major Vietnamese cities. The analysis revealed that all five policy areas significantly contribute to sustainable growth, with renewable energy policies and green technology innovation having the strongest influence. The study found a high explanatory power of the model (R-squared = 0.765), indicating that these policies account for 76.5% of the variance in sustainable growth. Despite progress, challenges in policy implementation and resource mobilization persist. The research proposes targeted solutions, including strengthening renewable energy initiatives, promoting sustainable agricultural practices, and improving policy coordination. These findings provide a robust empirical basis for refining Vietnam's green economic strategies, offering valuable insights for policymakers in Vietnam and other developing countries transitioning towards sustainable growth amidst climate change and resource constraints.

Keywords: *Green economic policies, green finance, renewable energy, sustainable growth, Vietnam*

1. Introduction

The transition towards a green economy has become increasingly crucial for sustainable development worldwide, and Vietnam is no exception (Nguyen, 2018). As a rapidly developing country, Vietnam faces significant challenges in balancing economic growth with environmental sustainability and social equity. The country's economic progress has been accompanied by environmental degradation, resource depletion, and rising greenhouse gas emissions, highlighting the urgent need for green economic policies (Tran, 2016).

Despite the Vietnamese government's recognition of the importance of green growth, as evidenced by the National Green Growth Strategy (2012) and the revised version (2021), the implementation and effectiveness of green economic policies remain uncertain (Ngo & Tran, 2020). There is a lack of comprehensive research evaluating the impact of these policies on sustainable growth in Vietnam, particularly in key areas such as renewable energy, resource management, green technology innovation, green finance, and sustainable agriculture (Pham et al., 2012).

Furthermore, the interplay between various green economic policies and their collective impact on sustainable growth is not well understood (Le & Nguyen, 2017). This knowledge gap hinders policymakers' ability to prioritize and optimize policy interventions effectively. Additionally, the unique challenges and opportunities presented by Vietnam's socio-economic context in adopting green economic policies have not been thoroughly examined (Hoang & Pham, 2021).

This research aims to address these gaps by conducting a comprehensive assessment of the impact of green economic policies on sustainable growth in Vietnam. By analyzing the effectiveness of current policies, identifying key challenges, and proposing targeted solutions, this study seeks to contribute to the development of a more robust and effective green economic framework for Vietnam. The findings will not only inform policy decisions in Vietnam but also provide valuable insights for other developing countries facing similar challenges in their transition to a green economy (Cao et al., 2024).

2. Theoretical framework

The green economy concept, as defined by UNEP, emphasizes the interdependence of economic growth, social inclusiveness, and environmental sustainability (UNEP., 2011). This aligns closely with the principles of sustainable development, which seek to meet present needs without compromising future generations' capabilities (Brundtland, 1987). The Environmental Kuznets Curve hypothesis suggests a non-linear relationship between economic development and environmental degradation, potentially justifying initial environmental costs for long-term benefits (Grossman & Krueger, 1995). The Porter Hypothesis posits that well-designed environmental regulations can stimulate innovation and competitiveness (Porter, & van der Linde, 1995), while Ecological Modernization Theory proposes that continued industrial development can be leveraged to address environmental challenges (Mol, & Sonnenfel, 2000). These perspectives are complemented by the Triple Bottom Line framework, which emphasizes the need for businesses and governments to balance economic, social, and environmental concerns (Elkington, 1997). Together, these theories provide a comprehensive lens through which to analyze the impact of green economic policies on sustainable growth in Vietnam.

From the results of theoretical research and expert interviews, the author proposes a research model on the Impact of Green Economic Policies on Sustainable Growth in Vietnam, including 1) renewable energy policies; 2) resource and environmental management; 3) green technology innovation; 4) green finance; 5) sustainable agricultural development (Figure 1).

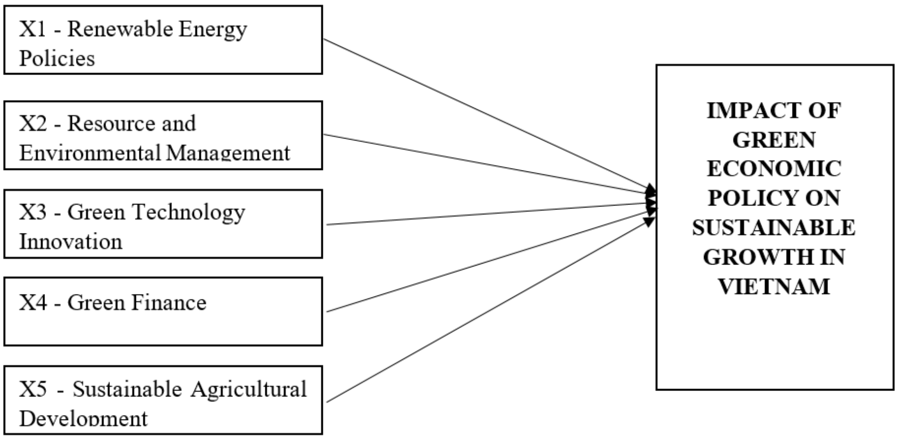

Figure 1: Research model

Source: Authors

This model allows for an examination of how different aspects of green economic policy contribute to sustainable growth, reflecting the multifaceted nature of the green economy concept and the interconnected principles of sustainable development. It provides a structured approach to assess the effectiveness of Vietnam's green economic strategies and their impact on the country's sustainable development trajectory.

3. Methods

Data collection methods: Secondary data from relevant research reports and publications from ministries, departments, agencies, and enterprises. Primary data gathered from surveys of 300 experts, policymakers, business leaders, and researchers in sustainable development from major cities such as Hanoi, Can Tho, Da Nang, and Ho Chi Minh City (Nguyen & Tran, 2020). To ensure objectivity of the research results, the sample is selected using a stratified random method based on the number of experts, businesses, recruitment websites, online candidate profiles, candidate management systems, and regulatory agency representatives Le & Pham, 2019).

Qualitative research method: Data collection, analysis of related research works, development of preliminary questionnaires, and interviews with 20 leaders and representatives from relevant organizations and experts to determine research indicators on the current situation and factors influencing the impact of green economic policies on sustainable growth in Vietnam (Hoang & Nguyen, 2021). The results serve as a basis for developing the official survey questionnaire, ensuring objectivity and providing evidence for research results, discussion, and proposed policy implications.

Quantitative research method: Using the survey results from 300 relevant experts, the author uses SPSS 26.0 software to test the scale, evaluate and analyze the factors influencing the impact of green economic policies on sustainable growth in Vietnam (Tran & Vu, 2022). The analysis and evaluation results form the basis for discussion and proposing policy implications to enhance sustainable growth in Vietnam.

4. Results and Discussion

4.1. Results

4.1.1. Cronbach's Alpha test results

To validate the scale measuring the impact of green economic policies on sustainable growth in Vietnam, Cronbach's alpha analysis was conducted (Table 1).

Table 1: Cronbach's Alpha reliability analysis results

Observed Variable	Total Inter-item Correlation Coefficient	Cronbach's Alpha if Variable Excluded	Cronbach's Alpha for Entire Scale
X1 - Renewable Energy Policies	0.546	0.692	0.843
X2 - Resource and Environmental Management	0.731	0.837	
X3 - Green Technology Innovation	0.773	0.868	
X4 - Green Finance	0.676	0.792	
X5 - Sustainable Agricultural Development	0.699	0.816	

Source: Authors

The overall Cronbach's alpha of 0.843 indicates good internal consistency reliability (Anderson, R. E. et al., 2019). All variables show satisfactory total inter-item correlation coefficients (0.546 to 0.773), exceeding the recommended minimum of 0.3 (Field, A., 2018). The "Cronbach's Alpha if Variable Excluded" values are all lower than the overall alpha, supporting the retention of all items (DeVellis, R. F., & Thorpe, C. T., 2021). Green Technology Innovation (X3) demonstrates the strongest contribution to scale reliability, while Renewable Energy Policies (X1) shows the lowest, though still valuable, correlation. The narrow range of "Alpha if Item Deleted" values (0.692 to 0.868) suggests good scale cohesion.

These results support the scale's reliability in measuring the impact of green economic policies on sustainable growth in Vietnam, justifying the use of all items in subsequent analyses.

4.1.2. Check for method changes and miscompatibility

The analysis of green economic policies' impact on sustainable growth in Vietnam yielded compelling results across multiple statistical approaches.

Principal Component Analysis revealed that five components explain 69.824% of the total variance, with the first component accounting for 38.304%, indicating strong construct validity of the measurement scale (Anderson, R. E. et al., 2019). The regression model demonstrated robust explanatory power, with an R value of 0.875 and an R Square of 0.765, suggesting that green economic policies explain 76.5% of the variance in sustainable growth (Field, A., 2018). The model's precision is underscored by a low standard error of estimate (0.40396) and a Durbin-Watson statistic of 1.651, indicating no significant autocorrelation in residuals (Tabachnick, B. G., & Fidell, L. S., 2019). ANOVA results further corroborated the model's significance, with an F-statistic of 191.351 ($p < 0.001$), strongly rejecting the null hypothesis of no linear relationship between predictors and the dependent variable (Cohen, J. et al.,2003). Collectively, these findings provide a solid statistical foundation, supporting the validity and reliability of the research framework and offering a robust basis for discussing the specific impacts of various green economic policies on sustainable growth in Vietnam.

Table 2: Principal component analysis, regression model, and ANOVA results

Analysis	Statistic	Value
Principal Component Analysis (PCA)	Total Variance Explained (5 components)	69.824%
	Eigenvalue of Component 1	7.661
	% of Variance of Component 1	38.304%
Regression Model	R	0.875
	R Square	0.765
	Adjusted R Square	0.761
	Std. Error of the Estimate	0.40396
	Durbin-Watson	1.651
ANOVA	F	191.351
	Sig.	0.000
	df (Regression)	5
	df (Residual)	294
	df (Total)	299

Source: Authors

4.1.3. Linear recovery feature analysis

Table 3: Linear regression test

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.607	.143		-4.241	.000		
	X1	.370	.037	.363	9.884	.000	.593	1.687
	X2	.148	.033	.159	4.526	.000	.647	1.546
	X3	.210	.033	.236	6.451	.000	.596	1.679
	X4	.147	.033	.149	4.420	.000	.707	1.415
	X5	.258	.035	.246	7.416	.000	.725	1.380

Source: Authors

The linear regression analysis provides compelling evidence for the significant impact of green economic policies on sustainable growth in Vietnam. All five predictors (X1-X5) demonstrate statistical significance ($p < 0.001$), with X1 emerging as the most influential factor ($\beta = 0.363$), followed by X5 ($\beta = 0.246$) and X3 ($\beta = 0.236$) (Anderson, R. E. et al., 2019). The absence of multicollinearity, as indicated by acceptable Tolerance (0.593-0.725) and VIF (1.380-1.687) values, ensures the unique contribution of each predictor to the model (Field, A., 2018). Positive unstandardized coefficients across all variables suggest that increases in each policy dimension correspond to improvements in sustainable growth, with X1 showing the strongest effect (B = 0.370) (Cohen, J. et al., 2003). The model's precision is underscored by relatively small standard errors, enhancing its predictive reliability. These findings not only validate the effectiveness of current green economic policies but also highlight potential areas for policy prioritization, particularly in relation to X1, which could represent renewable energy initiatives or similar high-impact strategies (Tabachnick, B. G., & Fidell, L. S., 2019). This comprehensive analysis provides a robust foundation for further research into the specific mechanisms through which these policies influence sustainable growth and potential synergies among different policy dimensions (Gujarati, D. N., & Porter, D. C., 2009).

Linear Regression: From the above results, we have the linear equation (Xi), (Y) as follows:

$$Y = -0.607 + 0.370*X1 + 0.148*X2 + 0.210*X3 + 0.147*X4 + 0.258*X5$$

4.2. Discussion

The analysis reveals several significant findings regarding the impact of green economic policies on sustainable growth in Vietnam:

Comprehensive policy impact: All five examined green economic policy areas (renewable energy, resource and environmental management, green technology innovation, green finance, and sustainable agricultural development) demonstrate statistically significant positive impacts on sustainable growth. This underscores the multifaceted nature of sustainable development and the importance of a holistic policy approach.

Relative policy importance: Renewable energy policies (X1) emerge as the most influential factor (β = 0.363), followed by sustainable agricultural development (X5, β = 0.246) and green technology innovation (X3, β = 0.236). This hierarchy suggests prioritization areas for policymakers, with a particular focus on accelerating the transition to renewable energy sources.

Synergistic policy effects: The absence of multicollinearity among predictors indicates that each policy area contributes uniquely to sustainable growth. This suggests potential synergies between different green economic policies, warranting further investigation into integrated policy frameworks.

Model robustness: The high R-squared value (0.765) indicates that the model explains a substantial portion of the variance in sustainable growth. This robust explanatory power validates the chosen policy areas as key drivers of sustainable development in Vietnam.

Implementation challenges: Despite the positive impacts observed, the study also highlights ongoing challenges in policy implementation and resource mobilization. This points to the need for enhanced governance structures and capacity building to fully realize the potential of green economic policies.

Contextual considerations: The findings underscore the importance of Vietnam's specific socio-economic context in shaping policy outcomes. The strong influence of agricultural policies, for instance, reflects the sector's significance in Vietnam's economy and suggests that green transformations must be tailored to local conditions.

Innovation and finance: The significant impacts of green technology innovation (X3) and green finance (X4) highlight the crucial role of technological advancement and financial mechanisms in driving sustainable growth. This suggests the need for policies that foster innovation ecosystems and develop robust green financial instruments.

These results provide a comprehensive picture of how green economic policies contribute to sustainable growth in Vietnam. They offer valuable insights for policymakers, emphasizing the need for a balanced, context-sensitive approach that leverages synergies between different policy areas. Future research could explore the specific mechanisms through which these policies influence sustainable growth and investigate potential interaction effects among the policy dimensions.

5. Solutions for developing green economic policy for sustainable growth in Vietnam

Strengthen renewable energy policies: This solution addresses the most influential factor (X1) identified in the study. It aims to accelerate Vietnam's transition to clean energy sources, reducing reliance on fossil fuels and mitigating climate change impacts. Enhancing the legal framework would provide clarity and stability for investors, potentially attracting more foreign direct investment in the renewable sector. Implementing attractive incentives, such as feed-in tariffs and tax breaks, could stimulate rapid growth in solar, wind, and biomass energy projects. Investing in grid infrastructure is crucial to accommodate the intermittent nature of renewable energy sources and ensure stable power supply. This comprehensive approach could significantly reduce Vietnam's carbon footprint while creating new jobs in the green energy sector.

Accelerate green technology innovation: Focusing on green technology innovation (X3) can drive sustainable growth through improved resource efficiency and reduced environmental impact. Increasing public funding for R&D can spur breakthroughs in areas like energy storage, waste management, and sustainable manufacturing. Creating innovation hubs for green tech startups can foster entrepreneurship and attract talent, potentially positioning Vietnam as a regional leader in green technology. Facilitating international technology transfer partnerships can accelerate adoption of best practices and cutting-edge technologies. This solution not only promotes sustainable growth but also enhances Vietnam's competitiveness in the global green economy.

Promote sustainable agricultural practices: As the second most influential factor (X5), sustainable agriculture is crucial for Vietnam, given its large agricultural sector. Developing climate-resilient farming techniques can help adapt to changing weather patterns and reduce crop losses. Policies to reduce chemical inputs can improve soil and water quality, enhancing long-term agricultural productivity. Establishing green supply chains can open new markets for Vietnamese products, particularly in eco-conscious international markets. This solution addresses environmental concerns while supporting rural livelihoods and food security.

Enhance green finance mechanisms: Developing robust green finance mechanisms (X4) is essential for funding the transition to a sustainable economy. A comprehensive green bond market can channel private capital into environmentally friendly projects. Preferential lending rates for green projects can incentivize businesses to adopt sustainable practices. Establishing a national green investment fund can provide crucial support for initiatives that might struggle to secure traditional financing. These mechanisms can help overcome the financial barriers often faced by sustainable development projects.

Improve policy integration and coordination: This solution aims to maximize the synergistic effects observed among different policy areas. A high-level inter-ministerial committee can ensure coherent policy-making across sectors, avoiding conflicting initiatives and leveraging complementarities. An integrated national sustainable development dashboard can provide real-time monitoring of progress, enabling data-driven decision-making. Regular policy reviews can help identify and address implementation challenges promptly. This coordinated approach can enhance the overall effectiveness of Vietnam's green economic policies, ensuring that efforts across different sectors reinforce each other for maximum impact.

By implementing these solutions, Vietnam can create a comprehensive and integrated approach to green economic development. This not only addresses environmental concerns but also positions the country for sustainable economic growth, enhanced competitiveness, and improved quality of life for its citizens. The solutions reflect a balance between immediate actions and long-term strategic planning, crucial for navigating the complex challenges of sustainable development in the face of climate change and resource constraints.

6. Conclusion

This comprehensive study on the impact of green economic policies on sustainable growth in Vietnam reveals significant positive effects across all examined policy areas, with renewable energy, sustainable agriculture, and green technology innovation emerging as the most influential factors. The research underscores the importance of a holistic, integrated approach that leverages synergies between different policy dimensions while addressing implementation challenges and adapting to local contexts. Key recommendations include strengthening renewable energy initiatives, accelerating green technology innovation, promoting sustainable agricultural practices, enhancing green finance mechanisms, and improving policy coordination. While the findings validate Vietnam's multifaceted approach to promoting a green economy, they also highlight the need for continued efforts in governance, capacity building, and innovative financing to fully realize the potential of these policies. As Vietnam navigates the complex challenges of sustainable development amidst climate change and resource constraints, this study provides a robust empirical basis for refining green economic strategies, potentially offering valuable insights for other developing countries in their transition towards sustainable growth.

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Factors Affecting Green Economic Development in Production Enterprises in Hanoi

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Abstract

With abrupt developments and epidemic outbreaks, rapid advancements in science and technology during the fourth industrial revolution, and a complex and unpredictable trajectory of climate change, green economic development offers the state's sustainable development strategy a comprehensive answer. Using survey data from 182 manufacturing businesses in Hanoi, the research examines the factors influencing the green economic development in manufacturing enterprises. Using SPSS 26 software, the author tests the regression model of six factors influencing the development of the green economy through qualitative and quantitative research methodologies. According to research findings, there are 6 factors affecting green economic development. Green economic development is: (1) Policy institutions, (2) Facilities, (3) investment capital, (4) Human resources, (5) Technology and (6) Awareness. Based on the study's findings, the author proposes solutions to enhance green economic development at manufacturing enterprises in Hanoi.

Keywords: Green economy, green economic development, manufacturing enterprises

1. Introduction

Vietnam has made great progress toward green economic development following a protracted era of growth predicated on cheap labor and natural resources. On the other hand, resource depletion, environmental pollution, and climate change pose significant problems to our nation. Vietnam must therefore take responsibility for addressing the global issues brought on by climate change, environmental pollution, and increasing economic competition. Creating a civilization that maximizes the value of resources, minimizes the exploitation of natural resources, minimizes waste and gas emissions into the environment, and protects people's health by using used raw materials instead of paying for processing. The economy must be oriented toward cutting-edge trends in order to lower the danger of crises resulting from overproduction of goods and scarce resources, generate new investment and employment possibilities, lower production costs, and lengthen the supply chain. Green economic development is a viable strategy for Vietnam's sustainable socio-economic growth, taking into account the country's natural resource constraints, based on both the country's current circumstances and the experience of developed nations. There are finite resources that progressively run out, and the environment is deteriorating. However, environmental protection measures are required in order for the public manufacturing sector to grow sustainably. Increasing the development of the green economy is one of those alternatives. Thus, the paper examines the variables influencing the growth of the green economic before outlining strategies to advance the green economic for manufacturing companies in Hanoi.

2. Literature review and Theoretical framework

2.1. Literature review

Kennet & Miriam (2007) in "Green Economics: An Introduction to Progressive Economics", introduced an overview of green economic development - an inevitable trend of the world economy. The author has generalized green economic development in the world by providing green economic development models that have been and are being implemented in a number of countries around the world.

Manish, B. & John, J. (2011) in “What is a “Green Economy” raised the concept of green economy, the manifestation of green economy in some countries such as Korea, China, and Mexico. In addition, the author also presents new features of the green economy, how the green economy is different from sustainable economic development and the difficult challenges or possibilities and opportunities of the green economy.

According to Weng et al. (2018), the connotation of green economic development is understood as: (i) Economic development must take into account resources and the environment; (ii) The main content of the green economy is to realize the "green" and "ecological" nature of economic activities; (iii) Developing a green economy requires people to both meet their living standards and not affect the quality of the ecological environment.

Zhihai, X., (2021) when researching the blue economy and blue ocean economy in China, found that government policy factors have a great influence on the development of the blue ocean economy here.

Linh, D. H. & Hang, N. T., (2021) emphasized the analysis of factors affecting green economic development strategies, thereby suggesting appropriate economic development policies in the context of the revolution. industry 4.0. Research results have shown 6 factors affecting green growth: (1) Policy institutions, (2) Facilities, (3) Investment capital, (4) Human resources, (5) Technology and (6) Awareness.

2.2. Theoretical framework

The United Nations Environment Program (UNEP) introduces the concept of a green economy as an economy that improves the quality of human life and social assets as well as focuses on preventing environmental dangers. environment and resource scarcity. A green economy emits little emissions, natural resources are exploited effectively, and society no longer has injustice. In a green economy, increased income and jobs are created from investments by the state and businesses that help reduce CO_2 as well as other sources of environmental harm, and optimize energy use. quantity and resources while preventing species from gradually decreasing in terms of individuals, species and ecological services (UNEP, 2011).

The concept of the "green economy" is used in relation to activities ranging from production, consumption, and lifestyle building; each activity associated with the word "green" represents the meaning of "environmentally friendly" at the United Nations Summit on Sustainable Development, which was held in June 2012 in Rio de Janeiro, Brazil (Rio +20) (UNEP, 2012). A green economy is associated with low carbon emissions, resource efficiency, and social fairness. The green economy is propelled by greater investment in sectors that contribute to the preservation and development of Earth's natural capital, reduce ecological degradation, and mitigate environmental risks. These sectors include clean technologies, advanced waste management systems, advanced clean water supply systems, low-carbon transportation, renewable energy, energy-efficient home construction, and sustainable agriculture, forestry, and fisheries industries (UNEP, 2010). In particular, this investment needs to be supported by domestic policy reforms, international policies and efforts to build market infrastructure.

The ideas of a green economy, an economy that both satisfies the need for economic growth and solves environmental challenges, have been mentioned by many researchers quite early. In particular, most studies agree that the trend of green economic development will focus on three main pillars: Industry, agriculture and services. Researchers also affirm that the concept of "green economy" does not replace the concept of sustainability, but it is increasingly recognized as a suitable model, as a foundation for sustainable development. Sustainability is an important long-term goal, but greening the economy is the means to bring each country to the goal of sustainable development.

Theory of sustainable resource management is centered on minimizing production waste by utilizing high-performance technical machinery, employing technical waste treatment procedures, and encouraging the generation of renewable energy. It is essential to optimize the production process in order to reduce adverse effects on the environment. Thus, managers' awareness of the use of sustainable resources has an impact on organizations' ability to develop sustainably.

In order to maintain sustainability and optimize value from available resources, the circular economy theory of production focuses on applying the ideas and practices of the circular economy to production operations. To maintain system sustainability and efficiency, it is critical that the concepts of the Theory of Circular Economy in manufacturing be used throughout the whole production supply chain, from product consumption to transportation and manufacture.

3. Methods

Qualitative research methods

Qualitative method is used for the purpose of discussing the factors affecting the green economic development. Based on the theoretical basis that has been synthesized, the author drafted a questionnaire with two main parts: part one explores the current situation of green economic development, part two studies the impact of factors on the implementation of green economic development in Hanoi.

Quantitative research methods

Data collection: According to Hair et al. (1998), the smallest sample size should be 50, preferably 100, and the ratio of observations/measured variables should be 5/1. The research model is built with 3 groups of factors measured through 28 observed variables, so the minimum number of samples is 140, the author selected 200 manufacturing enterprises in Hanoi. The sampling method is a convenient random method.

Data processing: Survey data processing is carried out in the next stage to screen out inappropriate survey forms due to blank answers or inconsistencies in the answers. The number of survey questionnaires included for data analysis included 185 valid questionnaires. The questionnaires included in the analysis were entered and processed using SPSS software with the main analysis techniques: descriptive statistics, EFA testing and regression analysis. Finally, there is the presentation of the research results and the presentation of the article.

Research model

Inheriting previous studies, the author builds a research model with 6 factors affecting green economic development:

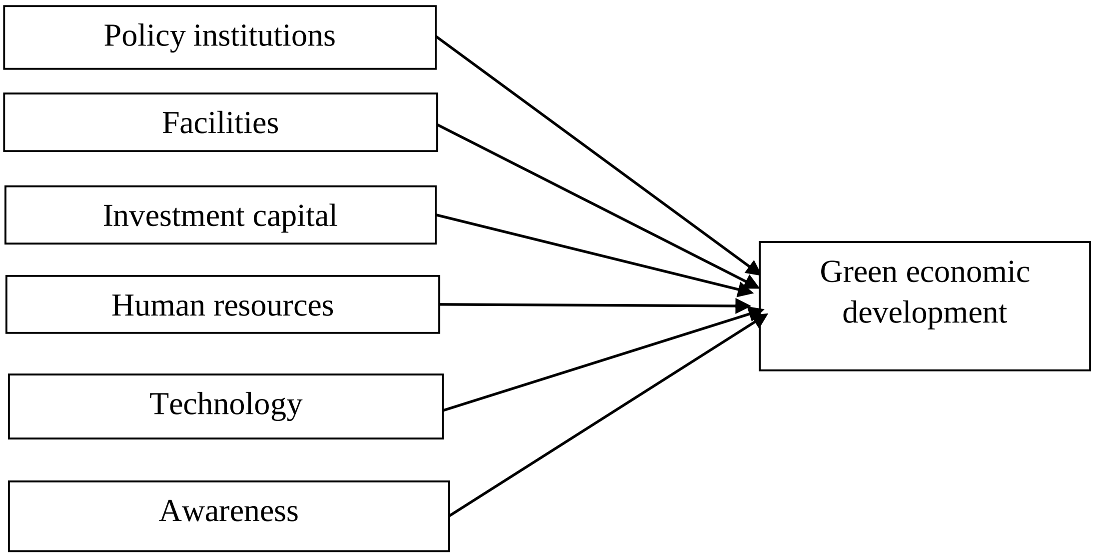

Figure 1: Research model

Source: Compiled by the author

Research model with research hypotheses as follows:

H1: Policy institutions positively affect green economic development
H2: Facilities positively affect green economic development

H3: Investment capital positively affect green economic development
H4: Human resources positively affect green economic development
H5: Technology positively affect green economic development
H6: Awareness positively affect green economic development

4. Results

4.1. Descriptive statistical results

The author conducted data processing and data analysis on 185 valid survey questionnaires obtained. The initial descriptive results are obtained and indicated in Table 1.

Table 1: Description of general information of the research sample

		Frequency	Ratio (%)
Gender	Female	106	57.30
	Female	79	42.70
Age	Under 40 years old	98	52.97
	From 41 to 59 years old	56	30.27
	Up to 60 years old	31	16.76
Academic level	university bachelor	82	44.32
	post-university degree	103	55.68
The level of green accounting practices in enterprises	Not yet applied	72	38.92
	Have ever applied	65	35.14
	Applying	48	25.95

Source: Compiled by the author

Through the descriptive statistics table, it can be seen that the level of green accounting application in enterprises is not high, still nearly 50% of manufacturing enterprises surveyed have not applied green accounting. Therefore, identifying factors that affect the application of green accounting at businesses is very important. On the basis of preliminary processed data, the author conducted an analysis of factors affecting the application of green accounting at manufacturing enterprises in Hanoi.

4.2. Cronbach's Alpha test

All Cronbach's alpha coefficients of the variables were ≥ 0.6, thus meeting the requirements to be included in factor analysis. At the same time, the total correlation coefficients of the observed variables all meet the requirement of ≥ 0.3, ensuring that the given scales can be trusted in a statistically significant way.

Table 2: Reliability Statistics

	Scale Mean if Item deleted	Scale Variance if Item deleted	Corrected Item – Tota Correlation	Cronbach's Alpha if Item deleted
Cronbach's Alpha = 0.879				
CS1	13.2699	8.393	.762	.837
CS2	13.0044	9.222	.629	.868
CS3	13.3407	8.315	.758	.837
CS4	13.6726	7.999	.780	.832
CS5	13.1549	9.465	.607	.872
Cronbach's Alpha=0.918				
VC1	8.3097	3.050	.821	.903
VC2	8.2566	2.938	.887	.849
VC3	8.3363	3.051	.815	.908
Cronbach's Alpha =0.926				
DT1	8.1903	1.764	.877	.855

	Scale Mean if Item deleted	Scale Variance if Item deleted	Corrected Item – Tota Correlation	Cronbach's Alpha if Item deleted
DT2	8.1726	1.797	.860	.869
DT3	8.3540	1.910	.784	.920
Cronbach's Alpha= 0.882				
NL1	12.3230	4.540	.591	.895
NL2	12.3584	4.284	.816	.818
NL3	12.4779	3.860	.780	.824
NL4	12.5265	3.762	.780	.824
Cronbach's Alpha = 0.874				
NT1	14.0929	8.040	.666	.842
NT2	14.3053	7.849	.724	.827
NT3	14.0354	8.345	.677	.839
NT4	13.8274	8.375	.638	.849
NT5	14.1283	7.650	.728	.826
Cronbach's Alpha =0.778				
CN1	10.5752	4.592	.510	.752
CN2	10.9292	3.933	.628	.691
CN3	10.8142	3.850	.626	.692
CN4	10.6637	3.949	.550	.736
Cronbach's Alpha=0.756				
GE1	11.6681	3.040	.620	.678
GE2	11.8142	2.854	.591	.706
GE3	11.0575	3.912	.551	.726
GE4	11.2168	3.744	.552	.720

Source: Compiled by the author

4.3. Exploratory factor analysis (EFA)

The data is tested using KMO = 0.704 (> 0.5), and the Sig of Bartlett's Test is 0.000, less than 0.05. These results demonstrate that the observations are correlated and fully consistent with factor analysis. The observed variables' factor loading factors are all greater than 0.5, the extracted total variance is 72.84% (greater than 50%), and the Eigenvalue coefficient is 1.261 (greater than 1).

The exploratory factor analysis was warranted for these tests. As a result, all of the scales chosen for the model's variables satisfy the criteria and are suitable for use in further research.

Table 3. Rotated Component Matrixa

KMO	0.704
Sig.	0
Eigenvalue	1.261
Cumulative %	72.84

Source: Compiled by the author

4.4. Results of regression analysis

The results of the multivariate regression analysis of the study is indicated in the Table 4. The results of the regression analysis of the model of factors affecting the intention to use T with 6 independent variables are as follows: Model fit test value sig. = 0.000 (< 0.05 shows that the variables in the model can explain the change in the dependent variable.

The linear regression model shows the impact of factors affecting green economic development in businesses: $GA = 0.187*CS + 0.180*VC + 0.145*DT + 0.223*NL + 0.144*CN + 0.168*NT + \alpha$

Testing the regression model and research hypotheses shows that the adjusted R2 coefficient (Adjusted R Square) = 0.532 (53.2%), so the research model is consistent with the research data at 53.2%. The model does not violate the assumptions of independence of errors and the VIF coefficient <2 shows that there is no multicollinearity phenomenon.

Table 4: Coefficients[a]

Coefficients[a]									
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	B
1	Constant	.478	.214		2.235	.026		
	CS	.152	.043	.187	3.509	.001	.737	1.357
	VC	.125	.038	.180	3.245	.001	.679	1.473
	DT	.130	.056	.145	2.332	.021	.535	1.868
	NL	.199	.046	.223	4.283	.000	.770	1.299
	CN	.128	.052	.144	2.444	.015	.602	1.661
	NT	.142	.051	.168	2.785	.006	.572	1.749
R= 0.738; R^2 =0.544, R^2 Square =0.532; F=43.566; Sig (F)= 0.000,								

Source: Compiled by the author

5. Conclusion and Recommendations

Green economic development is a new direction for sustainable development for manufacturing enterprises. State policies, the application of digital technology solutions, increased awareness, human resources, capital support and infrastructure development are important factors for green economic development in developing countries. manufacturing enterprises in Hanoi. To comprehensively develop a green economy, both achieving the goals of economic growth and sustainable business development, while ensuring social security and protecting the environment and ecosystem for the future, it is necessary to focus on to some of the following solutions.

Recommendations on state policies

- Consolidate and strengthen organizational capacity, mechanisms, and policies to manage the livestock and veterinary industries in a streamlined, professional, and effective manner appropriate to the market economy, international integration, and regulations. violate the law.
- Improve the State's policies and legal environment in green economic development. Environmental policies need to be adjusted to suit the new situation; The system of natural resources tax and environmental tax needs to be continuously researched to adjust and perfect... It is necessary to properly assess the risks and impacts of environmental pollution and overexploitation of natural resources through mechanisms such as taxes, raising awareness of responsibility in minimizing environmental pollution, restoring resources and ecosystems. Strengthen the organization of scientific seminars and forums to exchange knowledge and experience on green economic development.

Recommendations on infrastructure

- Invest in facilities related to water supply, waste treatment and energy systems.
- Upgrade the waste and exhaust treatment system from production activities, ensuring compliance with environmental regulations and reducing environmental pollution.
- Invest in building renewable and highly productive energy infrastructure, including using solar, wind, and biogas sources to generate energy for production activities.

Recommendation to increase investment capital

- Support investment capital for businesses to switch to green economic production

- Develop a funding mechanism for green economic programs and projects in livestock farming from international and domestic capital sources.
- Mobilizing capital sources: From state budget capital according to regulations; Combined with national target programs, agricultural extension programs, other programs, plans and projects; preferential loan capital, ODA capital (if any); Optimize investment capital sources.

Recommendations to strengthen human resources

Human resource training through training courses and seminars helps managers and employees improve their qualifications and skills in green economy, thereby applying the latest techniques and methods in management activities. production management.

Recommendations for applying digital technology

- Increase investment in science and technology, at the same time receive and transfer advanced technology suitable to Vietnamese conditions, promote research in green economic development fields such as reducing emissions carbon, developing renewable energy, environmentally friendly energy...
- The Government needs to invest more resources in the development and application of high technology and energy development, especially in the fields of production and export to meet the requirements of the international market; ensure that Vietnam's export products do not violate regulations on environmental and climate pollution.
- Businesses increase investment in using digital machinery and equipment.

Recommendations to raise awareness

- Innovate thinking in awareness of environmental protection with methods, behavior, and sense of responsibility towards nature and the environment.
- Propagating and educating about the environment is an important job, from which to take practical actions in restoring ecosystems, preserving biodiversity, preventing climate change... in every country. people, contributing to improving the effectiveness of strategies, programs and action plans that the Government has proposed, moving towards a green economy, green and sustainable development.

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Green Transformation towards a Sustainable Future in Vietnam

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Abstract

There is widespread acknowledgement of the multiple environmental stresses the world has been facing over the last decades. In addition, the challenges of sustainable development are profound in terms of deep poverty and inequality. Green transformations are required to ensure sustainable future at global and national levels. Vietnam has achieved high economic growth and remarkable economic restructuring over the past 30 years, contributing significant increase in per capita income for the people. However, Vietnam's economy still depends on the exploitation of natural resources; the use of natural resources is not efficient; economic activities cause severe pollution and environmental degradation and the economy is vulnerable to the impacts of climate change. This requires fundamental changes in the country’s development pathway in the coming period. This paper presents an overview of green transformation, analyses motivations and challenges of a green transformation in Vietnam and proposes some policy implications for a green transformation towards sustainable future in Vietnam.

Key words: *Green transformation, sustainable development*, *Vietnam*

1. Introduction

There is widespread acknowledgement of the multiple environmental stresses the world has been facing over the last decades, such as global climate change, loss of biological diversity due to land use change, air and water pollution, and waste discharge. The Global Risks Report 2024 ranked global risks by severity 10-years period indicating the the top five global risks, including extreme weather events, critical change to rarth systems, biodiversity loss and ecosystem collapse, natural resource shortages, and misinformation and disinformation. Environmental risks continue to dominate the risks landscape **(**World Economic Forum, 2024). Global surface temperature was 1.09°C higher in 2011–2020 than 1850–1900 and global mean sea level increased by 0.20m in 1901-2018 (IPCC, 2021). Global Resource Outlook 2024 shows that the annual global extraction of materials has grown from 30.9 billion tonnes in 1970 to 95.1 billion tonnes in 2020, and is expected to reach 106.6 billion tonnes in 2024 following an annual average growth rate of 2.3%. Consequently, the global average per capita demand for materials rose from 8.4 tonnes in 1970 to 13.2 tonnes in 2024. Extraction and processing of material resources (fossil fuels, minerals, non-metallic minerals and biomass) account for over 55 per cent of greenhouse gas emissions (GHG) and 40 per cent of particulate matter health related impacts (UNEP, 2024). In addition, the challenges of sustainable development are profound: at least one billion people caught in deep poverty, billions more facing serious material deprivations, environmental crises continuing to worsen, and global cooperation undercut by deep divisions among the major powers (Jeffrey D. Sachs *et al*, 2024). These problems arise from the unsustainable use of natural resources and economic activities (e.g. agricultural and industrial production), overconsumption, urban expansion that are not compatible with environmental goals. There is growing consensus that these will prove deeply damaging to human well-being and futures unless they are addressed.

Global financial and ecological crises in recent years have once again raised issues about the ecological, social and economic sustainability of the global economy. Countries are now working towards a green transformation that can lead to a brighter, more prosperous, and sustainable future. Across the world, countries are starting to rethink their options for long-term prosperity given rising concerns about the global environment, the need to sustain and protect their domestic environment and natural capital, and the desire to promote strong inclusive social development. Achieving green transformation serves the objectives such as protecting the environment, combatting climate change, developing green economy, protecting future generations, and ensuring sustainability of social life.

Vietnam has achieved high economic growth and remarkable economic restructuring over the past 30 years, contributing significant increase in per capita income for the people. However, Vietnam's economy still depends on the exploitation of natural resources and the use of natural resources is not efficient; at the same time economic activities cause severe pollution and environmental degradation. In addition, the economy is vulnerable to the impacts of climate change. This requires fundamental changes in the country's development pathway in the coming period. Green transformations are required to ensure sustainable future in Vietnam.

This paper presents an overview of green transformation, analyses motivations and challenges of green transformation in Vietnam and proposes some policy implications for a green transformation towards sustainable future in Vietnam.

2. Literature review

The idea that our societies and economies are in urgent need of green transformation has attracted attention across political, policy and public debate for many decades. Many agree that the world is on an unsustainable path and that business-as-usual is not an option. Such visions partly reflect longstanding debates about how to reconcile environment and development, or growth and sustainability. Discussions about green transformations have been evolved from debates about sustainable development by Brundtland (1987), Rio Earth Summit in 1992 (Agenda 21), Sustainable Development Goals (2015), the Paris Agreement on the Climate (2015), and 1,5^{o}C IPCC Report (2018). However, sustainable development and green economy are not the only ways of framing green transformations.

Green transformation has increasingly become a key concept within sustainability climate change and sustainability studies over the last decades. The term 'green' has carried many meanings in the academic literature as well as in political and policy debates regarding environmental limits (e.g. growth and progress must keep within limits of the environment whether in relation to climate change, biodiversity, water, land, oceans); 2^{o}C or 1,5^{o}C target (e.g. any increase in average global temperature should be limited to 2^{o}C or 1,5^{o}C target above the pre-industrial level in 1880); planetary boundaries (e.g. a safe operating space for humanity should be defined to avoid dramatically compromise development at global level) (Ian Scoones *et al*, 2015).

There is a variety of approaches to green transformation, ranging from those focusing on environment to those focusing also on social justice and distribution (green and just transformations). Green transformations should be technology-led (finding the right combination of technologies to meet rising demands in greener ways to reduce ecological footprints through technological innovation without altering systems fundamentally, e.g, low-carbon energy, less water-intensive systems), marketized (emphasizing the need to recognize and value economically the natural capital by putting a price on nature as a way to overcome market failures, e.g. pricing, creating markets, property rights regimes), state-led (emphasizing the central role of state actions in such areas as energy efficiency, renewable energy, water quality improvement, agricultural and landscape management, public transport and pollution control) or citizen-led (involvement of civil society groups to implement sustainable practices) (Ian Scoones *et al*, 2015).

In general, green transformation means adopting environmentally friendly technologies, prioritizing sustainability goals, and developing policies and practices to protect natural resources. The concept of green transformation requires the design of all economic activities with environmental goals, especially responsible production and consumption. It encompasses a wide framework that includes all of practices such as increased use of renewable energy sources and improved energy efficiency, development and production of more sustainable and green products, resource efficiency in production, waste reduction and recycling, transition to a circular economy/production, development of greener and more sustainable transportation systems, development of environmentally friendly food systems, conservation of natural resources; and sustainable use of natural habitats. Green transformation has emerged as a response to climate change, depletion of natural resources, and environmental challenges.

3. Methods

Data collection: The study uses secondary data and information which were collected from a variety of sources, including reports from Vietnam's Government Statistics Office, Vietnam's Ministry of Natural Resources and Environment, books, journals, papers, and research reports of individuals and organizations related to the research topic.

Data analysis: A desk-based approach combined with statistical, descriptive, and comparative methods are applied to address the research question.

4. Results

4.1. Overview of Vietnam's economy

Viet Nam is the third most populous country in the Southeast Asia (after Indonesia and the Philippines) and the 15th in the world. The country's population continues to increase over years and reached 100.3 million people in 2023 (GSO, 2023a). Over the last 30 years, Viet Nam has experienced considerable economic growth (Figure 1) which transformed Vietnam from a poor to a lower middle-income country in 2015. The average economic growth rate in the period 2011-2023 reached 5.74 percent per year.

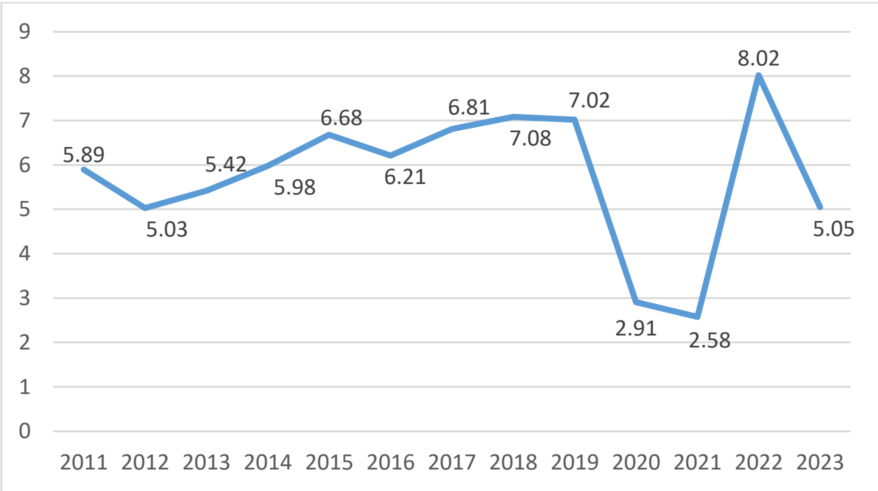

Figure 1: Vietnam's economic growth rate in 2011-2023 (%)

Source: Compiled by the author using data from Vietnam's General Statistics Office

After 30 years of economic reform, Vietnam has shifted its economic structure from being heavily dependent on agriculture to increasing the share of industry and services to GDP (Table 2). GDP per capita reached 4,284.5 USD in 2023 (GSO, 2023a).

Table 1: Vietnam's economic structure in 1985-2023 (%)

Economic sectors	1985	1995	2005	2015	2023
Agriculture – Forestry - Fisheries	40.2	27.2	20.97	17.00	11.96
Construction and Industry	27.4	28.8	41.02	33.25	37.12
Services	32.4	44.0	38.01	39.75	42.54

Source: Compiled by the author using data from Vietnam's General Statistics Office

In addition, progress has been made in all fields of social life, including education and health. Poverty has declined rapidly over the years. Access to basic infrastructure, including electricity, water and sanitation, has also significantly improved. Massive restructuring, especially public investment, state-owned enterprises and the banking sector, has taken place in recent years. Information and communication technology have developed rapidly, which is a key instrument for maintaining and promoting the competitiveness of the economy. In addition, Viet Nam has increasingly been integrated into global production and value chains, with export-oriented light manufacturing being a major stimulus of GDP growth in Vietnam.

Rapid population growth, industrialization and urbanization have led to significant increase in use of natural resources and waste generation in Vietnam (GSO, 2023b). Accompanying with socio-economic development, Vietnam is predicted to be particularly sensitive to global climate change and is considered as one of the ten countries most negatively impacted by climate change. Over the last decade (period 2000-2019), Viet Nam was ranked 13th of 180 countries on the Global Climate Risk Index with average losses of 11 million USD (PPP) in 2000-2019 (Germanwatch, 2021). Therefore, green transformation plays a vital role for sustainable development in Vietnam.

4.2. Motivations for a green transformation in Vietnam

There are several motivations for a green transformation in Vietnam.

First, Vietnam's economy is heavily dependent on exploitation of natural resources and inefficient use of natural resources. Natural resources have made great contributions to Vietnam's economy, especially in the agriculture-forestry-fishery sector, mining industry and commodity export, which is the basis for ensuring food security as well as creating foreign exchange revenue for the country. Many studies show that a significant contribution to Vietnam's economic growth over the past three decades has been the result of the exploitation of natural resources, especially the maximum use of land and water, and large areas of forest have been cleared to serve export-oriented agricultural production. Vietnam also face the challenges of unsustainable exploitation of oil, gas, coal, iron, bauxite, uranium, construction materials to provide inputs for processing industries. Key export products of Vietnam are agriculture-forestry-fishery products, crude oil and coal, are grounded on natural resources with low-value added. Another critical issue is that use of natural resources is inefficient, in other words, resource loss in extraction is high and production processes are resource intensive (MONRE, 2021).

Second, economic activities in Vietnam are causing serious environmental pollution and degradation. The main sources of environmental pollution and degradation in Vietnam are agriculture, industry, construction and transportation (MONRE, 2021). Waste discharged from production and consumption are not well classified, collected and treated which results in poor environmental quality in Vietnam. In terms of EPI (Environmental Performance Index), Vietnam ranked 141th in 2020 and 178th in 2022 and 180th in 2024 among 180 countries (Yale School of Environment, 2024).

Third, greenhouse gas emissions in Vietnam increased over years. The country's rapid economic growth, urbanization, and industrialization over the last 30 years have been powered by a coal-dependent energy supply that creates significant GHG emissions. MONRE data showed that emissions from energy sector went up the most rapidly, from 25.6 $MtCO_2e$ (in 1994) to 246.8 $MtCO_2e$ (in 2014) and reached 205.8 151.4 $MtCO_2e$ (in 2016) due to the rapid increase in energy demand (MONRE 2014, 2017, 2020). Energy sector emits the largest proportion of GHG emissions in Vietnam, accounting for 65.5 percent of total GHG emissions in Vietnam in 2016 (MONRE, 2020). Viet Nam is one of the most GHG-intensive economies in East Asia (measured as emissions per unit of output) in Asia. In absolute terms, Vietnam's GHG emissions - 364 million tonnes of CO_2e in 2018 - amount to no more than 0.8 percent of global emissions, on par with Malaysia, Thailand, France, and the United Kingdom. GHG emissions per capita were 3.81 tonnes CO_2e in 2018, up from 0.79 tonnes in 2000, but still relatively low by regional and global standards (World Bank, 2022).

In general, economic activities in Vietnam have been mainly based on the traditional approach of a linear economy which is the underlying cause of over exploitation of natural resources and cause serious environmental pollution and degradation and climate change in Vietnam. This requires Vietnam to change its `approach and transform its growth model to be greener in the future.

5. Discussion and Policy Implications

5.1. Current policy framework for a green transformation in Vietnam

The Government of Viet Nam has made remarkable efforts to develop and implement national laws, strategies, and action plans to promote a low-carbon development pathway, reduce vulnerability to the impacts of natural disasters and climate change, and enhance green growth and sustainable development, notably the Natural Resource Tax Law (2009), the Environmental Tax Law (2010), the Mineral Law (2010), the Law on Efficient Use of Energy (2010), Law on Water Resources (2012), Law on Natural Disaster Prevention and Control (2013), Law on Environmental Protection (2014, 2020), the Law on Meteorology and Hydrology (2015), the Law on Environmental Protection (2020), the Party's Resolution 24/NQ-TW dated June 3, 2013 on climate change response, natural resource management and environmental protection, the Party's Resolution No. 08/NQ-CP dated January 23, 2014 on Action Plan to implement Resolution No. 24 -NQ/TW dated June 3, 2013 of the 11th Party Central Committee, National Green Growth Strategy (2012, 2021), National Climate Change Strategy (2011, 2022), and the National Action Plan for the implementation of the 2030 Sustainable Development Program. The Extended Producer Responsibility provisions under the Law on Environmental Protection (2020), Scheme of Circular Economy Development in Vietnam (2022), the Socio-Economic Development Strategy (2011-2020, 2021-2030).

Climate change response efforts and initiatives in Vietnam have also been reflected in Vietnam's Agenda 21 on Sustainable Development (2004), the National Strategy and Plan on Disaster Management and Mitigation (2001-2020, 2021-2030). Viet Nam also fulfil international commitments on climate change. Vietnam signed the UNFCCC in 1992 and ratified it in 1994; signed the Kyoto Protocol in 1998 and ratified it in 2002. Vietnam submitted National Communications to UNFCCC (2003, 2010, 2019) and Biennial update reports (2014, 2017, 2020). INDC (Intended Nationally Determined Contribution) was submitted in 2015. Recently, Vietnam signed the Paris Agreement on the Climate in April, 2016; approved the Paris Agreement in November, 2016 and updated its NDC in 2020.

In fact, Vietnam has not yet introduced a specific law or policy on green transformation. However, many government policies and regulations have referred to the green transformation principles, such as green growth, circular economy, rational and economical use of natural resources, waste reduction, collection, reuse and recycling, development of environmentally friendly products.

5.2. Challenges for a green transformation in Vietnam

Vietnam has been facing with several challenges for a green transformation.

First, Vietnam has not really formulated environmental industries. There is a lack of technology-capable enterprises to recycle, reuse and recover used products and materials. Most Vietnamese enterprises are small and medium-sized; they have difficulty in the investments in technological innovation in the short term.

Second, the energy sector in Viet Nam have been facing challenges. Viet Nam is heavily dependent on fossil fuels in the total primary energy supply while *renewable energy is underdeveloped* energy consumption is inefficiently.

Third, green transition is associated with technology development, digital economy and industrial revolution 4.0 which needs to be further developed and enhanced in Vietnam in the coming years.

Fourth, tt is difficult to immediately change the production and consumption habits of the whole society from many easy-to-use products (e.g. plastic bags) to recyclable products.

5.3. Policy implications

Many researchers agree that a green transition is critical for Vietnam to achieve Sustainable Development Goals (SDGs) and ensure a sustaible future.

Economic restructuring towards a circular economy: The issues of natural resource depletion, environmental pollution and climate change risks have raised the need for Vietnam to change the economic model from a linear economy to circular economy. Vietnam should reduce energy-intensive and inefficient industries (steel, cement) and at the same time enhancing clean and green manufacturing industries and services (tourism), restoring natural ecosystems (especially forests) that are resilient to climate change to enhance carbon storage. Institutionalizing the circular economy model plays a vital role.

Energy transition: Particular focus is placed on green electricity development (gradually replace fossil fuel-based electricity sources; increase the proportion of renewable energy in electricity production; upgrade and invest in the power grid and transmission system) and renewable energy development (enhancement of offshore wind power, floating solar power at hydropower dams, integrating solar energy with agriculture; investment in renewable energy with the support of financial institutions; targets of renewable energy development, net zero emissions and reduction of air pollution should become criteria for considering and approving investment and energy projects

Climate and environmental friendly technology: Enhancing emission reduction technologies and applications in energy, construction and building materials, waste management and processing, manufacturing, agriculture and transportation; accelerate the application of the best available technology (BAT) to gradually replace the existing outdated production lines that cause serious environmental pollution; examine the possibility of using advanced technologies that have not been used in Vietnam (carbon capture and utilization and storage solutions and hydrogen energy).

Mobilization and efficient use of investment resources for green transition: Restructuring public investment (e.g. investment capital is arranged to focus on low-carbon production and consumption) and encouraging and attracting non-state budget investment (e.g. enhance public-private partnerships for infrastructure development for the green industry, eco-industrial parks, organic agriculture, and environmental services; building financial institutions to support cleaner production enterprises and new circular business models

Awareness raising on green transformation: Building a green society where people are more engaged and actively responsible for reducing, reusing, and recycling wastes, especially plastic wastes; promoting green lifestyle and sustainable production and consumption models; enhancing the social responsibility of enterprises and citizens in compliance with environmental protection legislation and the efficient use of resources; designing and implementing communication programs to raise public awareness of schools, residential communities, state agencies, and production and business establishments on environmental protection and circular economy

6. Conclusion

A growing number of global environmental risks affecting food, health, livelihoods, energy, and security will undermine the viability of national economies and societies. Governments around the world are successfully formulating integrated sustainable development strategies and institutional structures to achieve the SDGs. Many countries are already taking serious action towards a green transformation across their economies and industries, in cities and rural areas. At the international level, the 2030 Agenda's 17 Sustainable Development Goals (SDGs), the Paris Agreement on climate change, and other measures have been adopted.

Greening is a process rather than a measurable endstate. The term 'green' is not just reduced to green technology or business, but to more radical shifts to sustainable practices of the whole society. The constitution of green transformations varies depending on the setting in which they are occurring. Measures can be implemented across a range of sectors, including energy production, transportation, agriculture, and urban planning. Collaboration among different sectors of society, including businesses, nongovernmental organizations, and governments, is essential in this process.

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Challenges and Progress in Implementing Sustainable Development and Green Growth in Vietnam

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Abstract

Vietnam is actively pursuing a sustainable development trajectory in response to global environmental challenges, focusing on key objectives such as Green Economy, Green Growth, Sustainable Development, Circular Economy, and Net Zero Emissions. This study evaluates these objectives, examining their influence on environmental enhancement and economic growth. Significant positive outcomes are noted, particularly from policies promoting renewable energy and circular economy practices. However, challenges remain, notably in the green energy transition, which poses risks of energy shortages and economic slowdown if not carefully managed. Additionally, the overlapping nature of objectives like Green Growth, Circular Economy, and Sustainable Development necessitates a coordinated approach to avoid inefficiencies. To further Vietnam's sustainability goals, this study recommends enhancing institutional frameworks, centralizing development goals under a unified agency, fostering community engagement, and improving communication and education. The importance of international cooperation is also emphasized, enabling the exchange of best practices and strengthening global commitments. These strategies are vital for Vietnam to effectively balance environmental protection with economic resilience amid the ongoing climate crisis.

Keywords: *Green economy, circular economy, emission reduction, sustainable development, green growth*

1. Introduction

The increasing global emphasis on sustainable and green development initiatives stems from the urgent need to address the multifaceted challenges of environmental degradation and climate change. Vietnam has responded proactively to these global imperatives, redirecting its development trajectory towards sustainability through a series of commitments and strategic goals. The key objectives of this effort include the promotion of a Green Economy (GE), Green Growth (GG), Sustainable Development (SD), Circular Economy (CE), and the achievement of Net Zero Emissions (NZE). Each of these objectives reflects the Vietnamese government's commitment to environmental protection and the green transition.

This study provides a comprehensive analysis of these primary objectives, exploring their interconnections, assessing the outcomes achieved thus far, and proposing solutions to enhance green and sustainable development in Vietnam.

2. Literature review

The interaction and potential conflicts between green and sustainable development goals have been the subject of extensive global discourse. Key discussions in the literature focus on the interplay between these goals, the actions required to realize them, the barriers encountered, and potential solutions. Central to these discussions is the debate over the effectiveness and sustainability of green growth models, the feasibility of such models across different national contexts, and the potential trade-offs between green transitions and economic growth, particularly in relation to energy supply constraints due to reduced fossil fuel usage (Basu et al., 2023; Belmonte-Ureña et al., 2021; Lai & Pham, 2022). Basu et al. (2023) examine the relationship between NZE, CE, and SD, arguing that the implementation of a Circular Economy is a prerequisite for achieving Net Zero Emissions. Their analysis suggests that economies with proactive environmental policies reach NZE targets more rapidly than those with passive approaches. The study proposes four key policy recommendations: enhancing the shift to renewable energy, increasing recycling rates, promoting pollution reduction, and reducing investment in non-renewable energy sources. Belmonte-Ureña et al. (2021) provide a critical review of the concepts of CE, degrowth, GE, and SD, highlighting differences in academic perspectives and national policies. Their review identifies that among the 17 Sustainable Development Goals (SDGs), certain goals such as SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action) are more prominently featured in the literature. In contrast, goals like SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 14 (Life Below Water), and SDG 17 (Partnerships for the Goals) receive comparatively less attention. A significant issue identified in the literature is whether green and sustainable development goals are inherently interdependent and, thus, must be pursued in an integrated manner. Ambiguities in sector-level implementation and the lack of clear definitions and indicators have led some enterprises and governments to adopt a selective approach, focusing on the most feasible or favorable SDGs. This prioritization often leans towards goals that are more easily integrated into enterprise strategies, such as CE, or those that align closely with state policies, such as GG (Belmonte-Ureña et al., 2021).

According to the Vietnam Science and Technology Publication Database, as of the time of this study, domestic research output on these topics includes 2,307 articles on SD, 173 on GG, 145 on CE, and 11 on NZE. Additionally, numerous seminars on GE and CE are regularly organized by universities and research institutes. However, much of the existing research and discussion tends to focus on the application, effectiveness, and specific models within certain sectors, or on the correlation between selected pairs of factors. Persistent misunderstandings between key concepts can lead to confusion, affecting the organization of scientific seminars and policy advice and potentially influencing current policy decisions. Moreover, the confusion surrounding the definitions and interrelations of these goals often results in vague and ineffective practical applications, leading to strategic and policy-making errors. Without a clear and accurate understanding of these concepts, stakeholders may face challenges in reaching a consensus and making progress during scientific discussions and policy development. Consequently, policies based on misinterpretations of these goals may lead to inefficient implementations, squandering time, resources, and financial investments. Therefore, it is crucial to establish clear definitions and a shared understanding of these concepts to ensure the success and effectiveness of current policies and measures.

The Vietnamese government has issued several key documents to establish a framework for green and sustainable development, including: Decision 1658/QD-TTg (2021): Approving the National Strategy on Green Growth for the period 2021-2030, with a vision to 2050; Decision 687/QD-TTg (2022): Approving the Circular Economy Development Scheme in Vietnam; Decision 882/QD-TTg (2022): Approving the National Action Plan on Green Growth for the period 2021-2030; Decision 841/QD-TTg (2023): Outlining the Roadmap for implementing Vietnam's Sustainable Development Goals by 2030; Decision 622/QD-TTg (2017): National Action Plan for implementing the 2030 Agenda for Sustainable Development. In addition, various ministerial-level documents manage more specific goals within these strategic projects.

3. Methods

This study employs a mixed-methods approach, combining qualitative and quantitative research methods to comprehensively examine the implementation and outcomes of sustainable and green development goals in Vietnam. The research methodology includes the following components:

3.1. Data collection

Data were gathered from a variety of sources to ensure a robust analysis, including secondary data: This includes official statistics, reports, and documents from governmental and international organizations such as the General Statistics Office of Vietnam, the Ministry of Industry and Trade, and Our World in Data. Additionally, academic articles, policy papers, and industry reports relevant to green growth, sustainable development, circular economy, and net zero emissions were reviewed to provide context and support for the analysis.

3.2. Data analysis

Quantitative analysis: Statistical methods were used to analyze trends in renewable energy production, CO_2 emissions, and economic indicators such as GDP. This analysis was supported by creating graphs and charts to visually represent the data, making it easier to identify trends and correlations.

Qualitative analysis: Thematic analysis was conducted on the qualitative data obtained from interviews and surveys. This approach helped identify key themes and patterns related to the implementation of sustainable and green development goals, including barriers, successes, and stakeholder perspectives.

3.3. Conceptual framework

A conceptual framework was developed to explore the interconnections between different sustainable and green development concepts, such as GG, SD, GE, CE, and NZE as mentioned above. This framework guided the analysis by structuring the relationship between these concepts and understanding how they influence each other in the context of Vietnam's development strategy.

3.4. Limitations

While this study provides a comprehensive analysis, it acknowledges certain limitations:

- *Data availability:* The availability and reliability of data, particularly in emerging areas such as green credit and circular economy, posed challenges. The study relied on available data, which may not fully capture the current state of these sectors.
- *Scope of study:* The study focused primarily on national-level policies and outcomes. Regional variations within Vietnam and sector-specific analysis, though important, were not exhaustively explored.

This methodology ensures that the research findings are grounded in a thorough analysis of both qualitative and quantitative data, providing a balanced and comprehensive understanding of Vietnam's progress towards its sustainable and green development goals.

4. Results

4.1. The relationship between the concepts of sustainable and green development

The concepts of Green Growth (GG) and Sustainable Development (SD) are foundational to understanding the broader framework of green and sustainable development. GG emphasizes economic development that simultaneously protects and enhances the environment, aiming to boost economic prosperity while minimizing the negative impacts on natural resources (Le, 2020). In contrast, SD is a broader goal that seeks to balance economic, social, and environmental aspects, ensuring long-term viability and equity across these dimensions (Nguyen, 2023). Within this framework, the Green Economy (GE) emerges as the practical mechanism to achieve both GG and SD. GE focuses on the sustainable use and development of resources, reducing pollution, and minimizing environmental impacts. The Circular Economy (CE) is an integral component of GE, emphasizing waste reduction and resource recycling, thereby contributing to an environmentally sustainable economic model (Le, 2020). NZE is a specific target within the green economy, focusing on the drastic reduction or elimination of greenhouse gas (GHG) emissions. Achieving NZE not only ensures a cleaner environment but also mitigates human impacts on natural ecosystems, essential for the sustainable development of the planet (Nguyen, 2022). These interconnected concepts form a cohesive system where the success of one element is contingent upon the positive interactions with the others. This interdependence is crucial for building a future that balances financial prosperity with environmental stewardship. Understanding these concepts (GG, SD, GE, CE, and NZE) is critical for setting the strategic direction of organizations, nations, and communities. A precise understanding of these definitions allows for the clear articulation of goals, which are essential not only for economic growth but also for minimizing social and environmental impacts. This clarity is vital for businesses, communities, and nations alike, requiring consensus and commitment from all stakeholders.

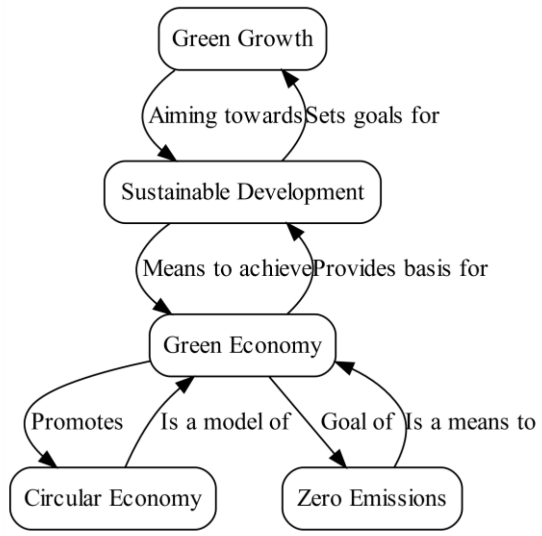

Figure 1: Schematic of Sustainable and Green Development Concepts

Source: Author

4.2. Achievements in sustainable and green development goals implementation in Vietnam

The implementation of green and sustainable development goals in Vietnam has led to several notable achievements:

4.2.1. Renewable energy production

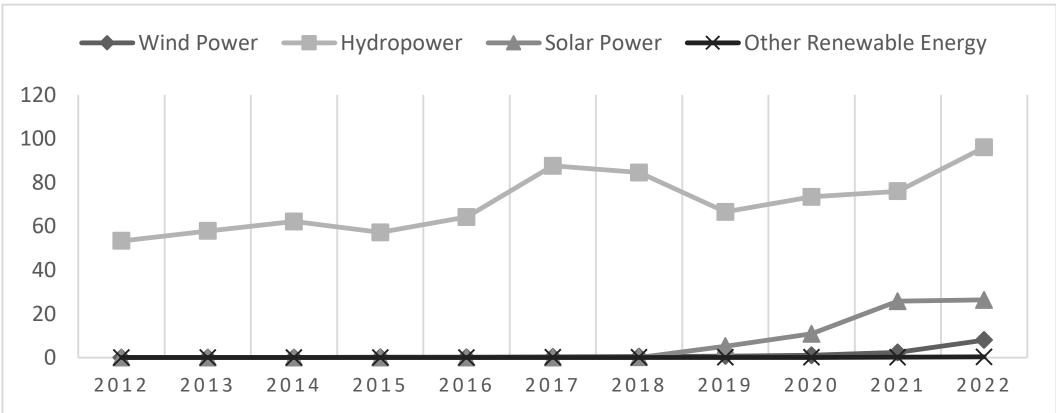

Figure 2: Renewable electricity production in Vietnam in 2012-2022 (Unit: TWh)

Source: Graph created by the author using data from Our World in Data

Vietnam has seen significant progress in renewable energy production. Hydropower remains the dominant renewable energy source. However, since 2019, other renewable energy sources, such as solar and wind, have expanded rapidly. This growth is driven by government policies encouraging private electricity production, advancements in technology reducing investment costs, and concerns over electricity shortages. Data indicates that by 2022, Vietnam produced 95.96 TWh of hydropower, 26.37 TWh of solar energy, and 8.04 TWh of wind energy, reflecting substantial increases in renewable energy capacity. Despite these advancements, challenges remain in the efficiency and stability of renewable energy systems. Policy issues also hinder integration into the national grid, particularly for solar power producers. As of January 2023, renewable energy accounted for 16.2% of the national electricity system, with solar and wind contributing 1.7 billion kWh and 1.21 billion kWh, respectively (Le Van, 2023). The government's approval of the Renewable Energy Development Strategy (Decision No. 2068/QD-TTg) underscores Vietnam's commitment to utilizing renewable energy to meet GE and NZE goals.

4.2.2. CO_2 emissions reduction

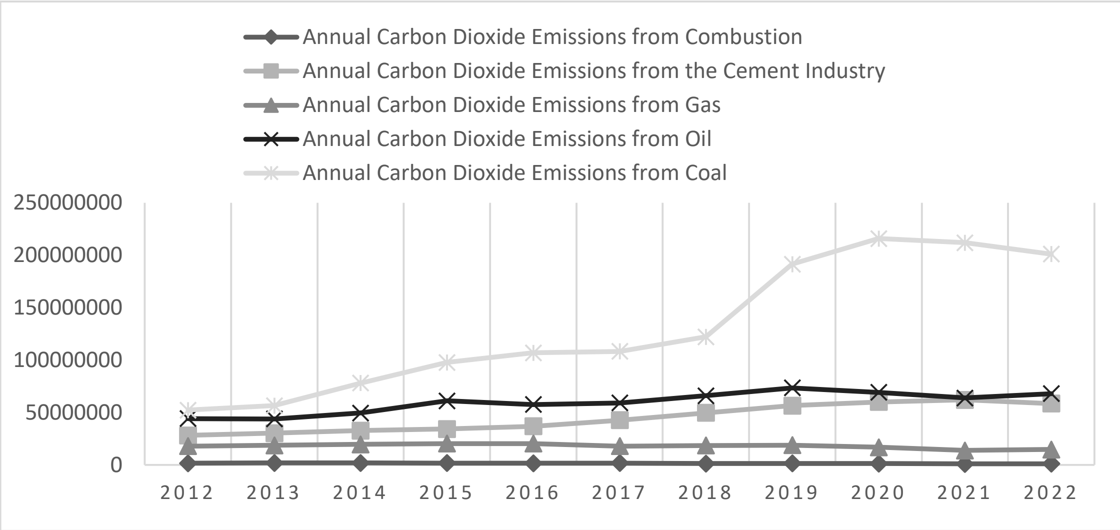

Figure 3: CO_2 emissions by sector in 2012-2022 (Unit: tons)

Source: Graph created by the author using data from Our World in Data

Vietnam's CO_2 emissions have slightly decreased since 2020, largely due to environmental policies. CO_2 emissions from coal decreased by 6.8%, equating to a reduction of 14,714,790 tons compared to the 2020 peak. However, coal remains the largest source of emissions, accounting for over 58% of total emissions. Despite the ongoing reliance on coal, the government has committed to not building new coal-fired power plants after 2030, aligning with COP 26 commitments. However, 18 coal-fired projects are still in the pipeline. Technologically, coal-fired power is currently necessary to balance the load with less stable renewable sources, especially in the absence of nuclear power in Vietnam.

4.2.3. Economic growth and CO_2 emissions

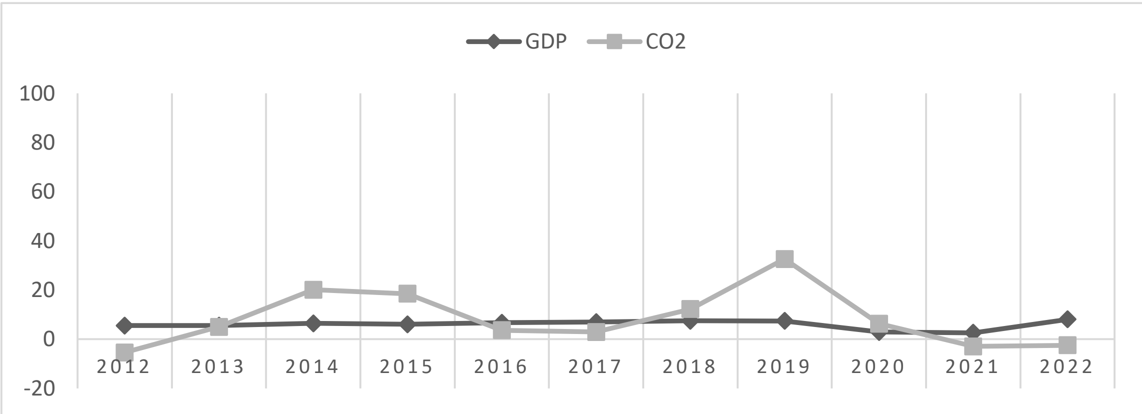

Figure 4: Annual changes in GDP and CO_2 emissions, Vietnam (Unit: %)

Source: Graph created by the author using data from Our World in Data and the General Statistics Office of Vietnam

Vietnam has also made strides in decoupling economic growth from CO_2 emissions. Between 2018 and 2020, the country achieved a notable reduction in the CO_2-to-GDP ratio, reflecting efforts to green the economy by reducing the share of polluting industries. In 2022, Vietnam surpassed its carbon emission reduction target, achieving an 8% economic growth rate while maintaining a corresponding level of CO_2 emissions growth. These achievements are consistent with the objectives outlined in the National Strategy on Green Growth for the 2021-2030 period, which aims for a 15% reduction in GHG emission intensity per GDP by 2030 and a 30% reduction by 2050 compared to 2014 levels (Le, 2023). The results indicate that Vietnam has made significant progress in reducing CO_2 emissions while sustaining economic growth, demonstrating the potential for achieving sustainable and green development goals (Kirkegaard, 2023a).

4.3. Advantages and challenges in implementing green and sustainable development goals in Vietnam

4.3.1. Advantages

Consistent legal framework: Vietnam has made significant progress in developing a more consistent and unified legal framework that aligns with market economy principles. This creates a stable foundation for promoting green and sustainable development. The legal infrastructure supports the enforcement of environmental standards and policies, ensuring that economic growth does not come at the expense of environmental degradation (Kirkegaard, 2023b).

Technological advancements: The rapid pace of technological innovation, particularly within the context of the Fourth Industrial Revolution and advancements in artificial intelligence, is driving new solutions and business models that promote resource efficiency. These technologies are pivotal in enabling Vietnam to achieve its green and sustainable development goals by optimizing resource use, reducing waste, and enhancing productivity across various sectors.

Green credit: Green credit has emerged as a vital tool for mobilizing capital towards environmentally beneficial projects, particularly in climate change mitigation and supporting sustainable development. Between 2017 and 2021, green credit loans in Vietnam saw an average annual growth rate of over 25%, outpacing the overall credit growth rate in the economy. However, green credit remains a small portion of the total outstanding loans, accounting for only 4.32%. Despite its nascent stage, green credit is primarily concentrated in green agriculture and sustainable water management, with increasing investments in renewable and clean energy sectors. Notably, the State Bank of Vietnam (SBV) has issued several directives, including Directive No. 03/CT-NHNN in 2015 and Circular No. 17/2022/TT-NHNN in 2022, to promote green credit growth and manage environmental risks in credit activities. The green capital market in Vietnam holds substantial potential to attract both domestic and international investors into key sectors like renewable energy, waste management, and low-carbon transportation (PwC Viet Nam, 2022).

Consumer awareness and demand: The rising awareness among domestic consumers regarding environmental issues is driving demand for cleaner production processes and more environmentally friendly goods and services. This shift in consumer behavior is pushing businesses to innovate and adopt more sustainable practices, contributing to the overall goals of green and sustainable development.

International integration: Vietnam's deepening international integration has introduced external pressures to transform its production and business sectors to meet global standards for environmental protection, recycling, and reuse. This process has been bolstered by diverse forms of support from the international community, facilitating the adoption of green and sustainable practices.

4.3.2. Challenges

Government role and coordination: A significant challenge lies in the government's role in supporting, guiding, and coordinating efforts towards the efficient use of natural resources and the promotion of environmentally friendly production and consumption. The lack of a systematic governance approach has resulted in inconsistencies in strategy development and policy implementation. Furthermore, coordination between different governmental levels and sectors is often ineffective, with limited interdisciplinary and interregional perspectives. This issue is exacerbated by the absence of a central coordinating body to oversee comprehensive activities related to green and sustainable development.

Effectiveness of legal regulations: While Vietnam has established a legal framework for green and sustainable development, the effectiveness and enforcement of these regulations remain limited. Key policy tools, such as public investment, consumer rights, value-added tax, and environmental protection tax, are not yet fully harmonized to ensure transparency, fairness, and sustainability in resource use. Moreover, existing legal policies have not sufficiently incentivized technological innovation, corporate social responsibility, or responsible consumption, all of which are critical for advancing green and sustainable development.

Information and monitoring systems: Another challenge is the lack of robust information systems, data, and monitoring mechanisms necessary for implementing a green transition and circular economy. The absence of these systems results in analyses and evaluations based on outdated or incomplete information. Different management agencies often maintain separate sets of data, leading to inconsistencies and inefficiencies in tracking progress and making informed decisions.

Addressing these challenges requires a comprehensive and coordinated effort across all sectors and levels of government, supported by active engagement from the private sector and civil society.

5. Discussion

5.1. Positive environmental changes as indicators of effective policy

Positive environmental changes, as evidenced by measurable indicators, serve as both signs and strong affirmations of the effective implementation of environmental protection policies. These changes underscore the continuous efforts of the government, businesses, and citizens in Vietnam to mitigate the harm caused by human activities to the Earth. The visible outcomes of these policies reflect a reversal of environmental degradation, signaling that proactive measures can indeed lead to tangible improvements. For instance, investments in renewable energy, the development of low-emission transportation systems, the promotion of circular economy models, and the enforcement of strict environmental standards in industrial production have contributed to significant positive shifts in the nation's environmental landscape. These initiatives not only reduce environmental impacts but also foster economic opportunities, creating jobs in emerging green industries and promoting overall sustainable development. The increased awareness and commitment of the community also play a pivotal role in driving positive environmental changes. As public consciousness regarding environmental protection grows, individuals are adopting more sustainable practices in their daily lives, such as recycling, energy conservation, and reducing the use of single-use plastics. Community-driven movements, including tree planting, protecting natural areas, and environmental education for the younger generation, further amplify these efforts, fostering a culture of environmental stewardship and encouraging widespread participation in sustainability initiatives.

5.2. Emission reduction, green transition, and the risk of energy shortage and slowed growth

The global shift towards reducing emissions and transitioning to green energy is essential for mitigating climate change and promoting sustainable development. However, this transition is not without its challenges, particularly the risk of energy shortages and potential impacts on economic growth. A significant concern is the possibility of energy shortages during the transition to green energy sources. Without adequate planning and development of new energy systems to meet growing demand, Vietnam could face disruptions in energy supply. This risk is compounded by the fact that transitioning too rapidly, without careful management, could slow economic growth. The lack of comprehensive economic development plans that account for the complexities of energy transition can adversely affect various industrial sectors, potentially leading to economic instability. Vietnam's energy transition, therefore, requires careful consideration to ensure that energy security and economic development are maintained. Lessons from other countries highlight the importance of developing and implementing large-scale, medium, and long-term policies focused on energy conservation and the development of new energy sources. Opening the market to new technologies and creating favorable conditions for their development are also critical factors in ensuring a successful transition. Recent experiences in Europe, where the closure of coal and hydroelectric power plants for environmental reasons led to severe electricity shortages, serve as a cautionary tale. The ongoing Russia-Ukraine conflict has exacerbated these issues, prompting some countries to reconsider their energy strategies, including the potential revival of coal power plants. This situation underscores the delicate balance required in transitioning to green energy while ensuring that environmental efforts are not undermined by energy security concerns.

Government support policies are indispensable in this context, as they can promote investment and ensure that the green energy transition proceeds effectively and sustainably. By integrating energy and economic development plans with investments in energy-saving and renewable energy technologies, Vietnam can create opportunities for a sustainable future that balances environmental protection with economic growth. Effective management and implementation of these measures are crucial to minimizing the negative impacts of the green transition on economic growth while advancing emission reduction and sustainable development goals.

5.3. Overlapping impacts of green and sustainable development goals in Vietnam

Vietnam's goals of Green Growth (GG), Circular Economy (CE), Sustainable Development (SD), and Carbon Neutrality (CN) reflect a comprehensive vision for a future where environmental protection and social prosperity are harmonized. However, the implementation of these goals by various ministries and sectors often leads to overlaps in objectives and actions. To achieve the most unified and effective outcomes, a comprehensive evaluation of these overlaps is necessary.

Green growth (GG) is a strategic approach that focuses on restructuring the economy, transitioning growth models, and promoting sustainable development by efficiently using natural resources, enhancing competitiveness, innovating technology, and responding to climate change. GG shares common ground with SD, CE, and CN in their collective aim to reduce environmental impacts, increase carbon absorption, eliminate fossil fuel dependency, boost renewable energy use, and promote green production and consumption.

Sustainable development (SD) is a model that balances economic, social, and environmental factors to ensure that current and future generations can meet their needs without depleting ecosystem capabilities. SD's objectives overlap with those of GG, CE, and CN, as all strive for environmental protection, resource efficiency, and sustainable economic and social development. Vietnam's adoption of the global action framework for the 17 Sustainable Development Goals (SDGs) and 169 specific targets underscores the country's commitment to these objectives.

The circular economy (CE) represents a sustainable economic model that minimizes reliance on natural resources, enhances recycling, reuse, and regeneration of products and services, and reduces waste and greenhouse gas emissions. CE's goals are closely aligned with those of GG, SD, and CN, as they all aim to optimize resource cycles, minimize waste, increase efficiency, and protect the environment while creating economic value.

Carbon neutrality (CN) aims to balance greenhouse gas emissions with the amount removed from the atmosphere, ensuring no net increase in atmospheric greenhouse gases. CN's objectives align with GG, SD, and CE in their shared focus on protecting the Earth's climate system, limiting global warming, phasing out fossil fuels, increasing renewable energy use, afforesting, and applying carbon capture technologies. Vietnam's commitment to CN, as demonstrated at the COP26 conference, is supported by legal frameworks, community awareness efforts, and mobilization of resources for implementing these goals.

Addressing the overlapping impacts of these goals requires flexibility, creativity, and a deep understanding of the interconnectedness of development objectives. In practice, various projects and targets related to GG, SD, and environmental protection often involve multiple overlapping objectives and indicators, leading to discussions about the most effective projects or policies and the efficiency of investment in achieving specific targets. Given the multi-dimensional nature of sustainable and green development activities, it is crucial to evaluate their effectiveness in a holistic manner rather than in isolation.

5.4. Proposed solutions

Despite the progress made, the environmental challenges facing Vietnam remain significant, requiring robust international cooperation and commitment from all stakeholders. To address these challenges, several solutions are proposed:

Improve institutional systems, policies, and laws: Strengthening management capacity and law enforcement is essential to ensure consistency and transparency in data collection and processing related to sustainable and green development. This will enhance the effectiveness of policies and ensure that they are implemented uniformly across the country.

Unify goals and directions: Establishing a central coordinating agency for sustainable and green development is crucial to oversee all related activities effectively. Such an agency would enhance consistency and transparency in data handling, build and apply indicator systems and databases to track, assess, and report progress on sustainable and green development goals. A unified strategic goal would harness the roles and participation of all stakeholders, including businesses, social organizations, scientists, researchers, journalists, activists, and local leaders, in proposing, implementing, and monitoring sustainable and green development policies and projects. Additionally, a unified directive perspective would facilitate the allocation, mobilization, and enhancement of financial, technological, and human resources necessary for achieving these goals. This approach would also encourage green investments, create innovative financial mechanisms, and leverage resources from both domestic and international sources.

Enhance community participation and feedback: Increasing the involvement and input from the community, particularly among low-income groups, ethnic minorities, women, and children, is vital in the formulation and implementation of sustainable and green development goals. Inclusive participation ensures that the diverse needs and perspectives of all community members are considered, leading to more effective and equitable policies.

Strengthen information, communication, and education: Raising community awareness and responsibility, particularly among vulnerable groups, about the importance and benefits of sustainable and green development is essential. This can be achieved through targeted information campaigns, educational programs, and community engagement initiatives that highlight the critical role that every individual can play in achieving these goals.

Enhance international cooperation: Active participation in international forums and initiatives on sustainable and green development is crucial for Vietnam to share experiences, learn from other countries' lessons, and contribute to global commitments and actions. Strengthening international cooperation will also help Vietnam access new technologies, financial resources, and best practices that can accelerate its progress towards sustainability.

By implementing these solutions, Vietnam can continue to build on its progress and address the environmental challenges that lie ahead, creating a future where human activities and natural ecosystems coexist in harmony.

6. Conclusion

This study highlights Vietnam's ongoing efforts and the challenges it faces in pursuing sustainable development and green growth. The country's commitment to key objectives such as Green Economy, Green Growth, Sustainable Development, Circular Economy, and Net Zero Emissions reflects a broader vision of harmonizing economic growth with environmental stewardship. Positive environmental changes indicate the effectiveness of current policies, yet the journey is fraught with challenges, particularly in transitioning to green energy without compromising economic stability. The overlapping goals of various sustainability initiatives underscore the need for a more coordinated and integrated approach. Addressing these overlaps requires stronger institutional frameworks, central governance to unify development efforts, and enhanced community participation. Furthermore, Vietnam must continue to leverage international cooperation to bolster its sustainability agenda. Ultimately, Vietnam's success in achieving its green and sustainable development goals will depend on its ability to balance environmental protection with economic growth, ensuring that progress in one area does not hinder advances in another. By focusing on innovation, effective governance, and inclusive participation, Vietnam can navigate the complexities of sustainable development and emerge as a model for other nations facing similar challenges.

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Green Economy towards Sustainable Development in Vietnam - Current Situation and Solutions

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Abstract

Sustainable development is a global trend with the implication that economic growth must be associated with protecting and preventing environmental pollution. In the face of increasingly negative climate change and serious destruction of natural resources, green economic development is an inevitable choice for all countries over the world at present and in the future. This is considered the key to the sustainable development strategy of countries in the long term. The article presents an overview of sustainable development and green economy, analyzes the current status of green economic development in Vietnam in recent times. The research results show that with the important role of the Government, the support and companionship of international organizations, Vietnam has achieved initial achievements in the goal of greening the economy. However, green economic development in Vietnam still has some limitations such as: the legal system is not synchronous, there are no specific regulations on green energy, renewable energy; financial resources are limited; the quality of labor resources for the green economy has not met the requirements of high science and technology level; CO2 emissions tend to increase rapidly. On that basis, the author proposes some suggestions for Vietnam to develop the green economy associated with the comprehensive sustainable development of the country.

Keywords: *Green economy, sustainable development, Vietnam*

1. Introduction

In recent times, the sustainable development strategy in Vietnam of Agenda 21 has achieved important achievements and progress, highly appreciated by the international community. However, there are still challenges in the fields of economics, society, natural resources and environment that affect the implementation of sustainable development goals until 2030. In addition, the political report of the Central Executive Committee the 12th Party term has pointed out many internal limitations of the Vietnamese economy that the macroeconomic growth is good but not sustainable, leading to proposals to change the economic growth, green growth, green economic model with clean and renewable energy. The green economic model is known as a new development model that takes the environment, resources and people as the center of development.

The National Strategy on Green Growth for the period 2021-2030, vision 2050 issued by the Government demonstrates Vietnam's strong commitment to implementing sustainable development, through practical and specific actions. At the 2021 United Nations conference on climate change (COP26), the Prime Minister stated Vietnam's commitment to ‘develop and deploy stronger measures to reduce greenhouse gas emissions using its own resources, along with the cooperation and support of the international community, both in finance and technology transfer, including implementing mechanisms under the Paris Agreement, to achieve net emissions equal to 0 by year 2050’. The green economy appears as an inevitable choice for economic development, job creation and poverty prevention. In recent years, the Vietnamese Government has focused on the ‘green economy’, encouraged businesses to follow this trend in developing the national economy in depth and sustainably.

The article was conducted using qualitative research methods through desk research of relevant articles and documents. The author observed national data through secondary data collected in Vietnam. From there, the author analyzed, synthesized, and evaluated the current status of green economic development in Vietnam and made some policy recommendations to develop green economy associated with sustainable development of the country.

2. Theoretical framework

2.1. Sustainable development

2.1.1. Views on sustainable development

According to Sustainable Economics, sustainable development is the development process that achieves high enough ecological, economic and socio-cultural standards for current and future generations within the carrying capacity of nature. Specifically, the content of sustainable development includes three goals: economic, ecological and social goals. Among them, economic goals are the most important because these goals of sustainable development revolve around ensuring human needs in the long-term; social goals are to strive for equality in all aspects; environmental goals are to unequivocally preserve the basic foundations of nature that are the conditions for all life and economic activities and the ecological pillar must have the highest priority.

Originating from the reality of economic development and the consequences of the development process, the perspective of sustainable development in the world has been increasingly improved. The report of the World Council on Environment and Development (WCED) published in 1987 officially presented the United Nations' view on sustainable development, accordingly, sustainable development is understood as ‘development that meets the needs of present without hindering the ability to meet the needs of future generations’. This viewpoint has had a strong impact on the world community by warning humanity to fundamentally and immediately change its lifestyle and actions, otherwise it will face an intolerable situation and the environment will be destroyed to a catastrophic level.

At the beginning of the 21st century, the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002 continued to affirm that choosing the path of sustainable development in the world is absolutely correct. Agenda 21 has put forward a perspective on sustainable development that not only emphasizes environmental issues and natural resources but also emphasizes social and human factors in the development process of countries. Sustainable development is proposed by the United Nations as ensuring stable economic growth in relationship with good progress and social justice; reasonable exploitation, economical use of resources, protection and improvement of the quality of the living environment.

In the early 1990s of the last century, Vietnam began to ‘enter’ sustainable development, the Vietnamese Government took steps to increasingly fully approach the sustainable development journey of the economy. Specifically, on June 12th, 1991, in Decision No.187-CT, the Government approved the ‘National Plan on Environment and Sustainable Development for the period 1991 - 2000’, one of the first national plans that developed according to the perspective of sustainable development which has just been officially announced. On June 25th, 1998, the Politburo issued Directive No.36-CT/TW ‘on strengthening environmental protection in the period of industrialization and modernization of the country’ raising the viewpoint of environmental protection must be closely linked and ensured the sustainable development of nation. On August 17th, 2004, in Decision No.153/2004/QD-TTg, the Prime Minister issued the Strategic Orientation for Sustainable Development in Vietnam (Vietnam's Agenda 21) aiming to develop sustainably on basis of combining closely, reasonably and harmoniously between economic development, social development and environmental protection. On April 12th, 2012, the Prime Minister signed Decision No.432/QD-TTg approving the Vietnam Sustainable Development Strategy for the period 2011 - 2020. Accordingly, sustainable development is about implementing sustainable and effective growth, coupling with progress, social justice, protection of natural resources and the environment, maintaining socio-political stability, firmly protecting independence and sovereignty rights, unity and national territorial integrity.

2.1.2. Roles of sustainable development in Vietnam

Although ‘entering’ sustainable development slower than internationl community (about 10 years), the Party and State of Vietnam always pay attention and clearly define: sustainable development is a requirement throughout the strategy and the process of implementing the country's socio-economic development strategy. The role of sustainable development is concretized into a number of key points:

Firstly, sustainable development is the general trend of the world and an urgent requirement of our country. Placing the issue of Vietnam's sustainable development in the context of international integration is extremely important. Globalization and international integration in general have brought many advantages to each country's economic development. For Vietnam, this is reflected in the following aspects: (i) allow the expansion of markets for consuming products as well as other markets to help Vietnam develop based on the maximum mobilization of its advantages; (ii) overcome barriers to achieving economic growth goals fastly through supplementing the lack of necessary resources for development such as capital, highly qualified labor and more modern technology; (iii) improve the internal capacity of the economy due to the pressure of improving international competitiveness and leading to develop the economy more effectively.

Secondly, sustainable development plays a decisive role in achieving the goals of rapid and effective growth. Pursuing the goals and requirements of sustainable development, Vietnam needs to: (i) maintain macroeconomic stability and ensure economic security; (ii) restructure the economy actively and proactively, transform the growth model, consider quality, productivity, efficiency and competitiveness as top priorities, focus on in-depth development, develop a knowledge economy, conduct researches and apply the achievements of the 4.0 industrial revolution to the country's economic development.

Thirdly, sustainable development creates conditions to achieve the goals linking economic growth with cultural development and realizing social progress for people. The process of economic growth is associated with the process of continuously improving the quality of people's lives, strongly developing culture, promoting democracy and strengthening social consensus. Sustainable development is the basis for rapid growth, that create resources for sustainable development, improve people's lives, eliminate hunger and reduce poverty and soon shorten the development gap between countries. The process of implementing sustainable development goals will ensure political and social stability, strengthen national defense and security, and firmly protect independence, sovereignty, unity and territorial integrity.

Fourthly, sustainable development creates conditions for implementing the goals of protecting and preventing environmental pollution, effectively using resources and promptly responding to climate change. Implementing sustainable development goals: (i) emphasize protecting and improving environmental quality, create positive conditions and proactively prevent negative impacts on the environment due to economic activities caused; (ii) attach importance to reasonable exploitation, economical and effective use of natural resources within ecologically permissible limits and sustainable environmental protection; (iii) create conditions to predict climate change and its consequences, proactively propose policies and solutions to respond, including adaptation and mitigation of adverse impacts of climate change.

2.2. Green economy

2.2.1. Concept of green economy

Since the Second World War until now, the world economy has made great strides, achieved many important achievements, especially in the fields of science, technology and economics. However, the ‘brown economy’ modes of this period is not entirely superior. Countries only focus on exploiting natural resources but lack attention to efficiency, which helped them achieve high growth rates in the long term, but this development has caused certain consequences such as depletion and scarcity of natural resources, caused environmental pollution at alarming levels such as air, water, and ocean pollution; deforestation; increased greenhouse gas emissions such as C02, S02, CH4... leading to threat to socio-economic activities as well as human life. Therefore, green economic development is becoming a trend in the world, helping countries cope with current crises and prevent the risk of future crises. That is the way for countries to find new growth models aimed at restructuring their economies towards sustainable development.

According to the United Nations Environment Program (UNEP), a green economy is one that improves people's lives and social equity, significantly reduces environmental risks and ecological shortage. Simply put, a green economy has low emissions, uses resources efficiently and aims for social justice. According to the Organization for Economic Cooperation and Development (OECD), green growth is a way to achieve economic growth and development goals while preserving the environment, preventing biodiversity loss and minimizing unsustainable use of natural resources. According to the United Nations Economic and Social Commission for Asia-Pacific (ESCAP), green growth is an approach to achieving economic growth with the purpose of economic development while ensuring environmental sustainability.

It can be seen that the nature of the green economy is based on three main pillars, which are: (1) economic pillar: reducing poverty, improving the quality of public health care, developing clean energy, meeting the employment needs and promote growth...; (2) environmental pillar: ensuring sustainable production and consumption, conserving marine resources, protecting, regenerating and encouraging sustainable use of terrestrial ecosystems...; and (3) social pillar: improving the quality of education, narrowing the gender inequality gap and minimizing social inequality...

In other words, a green economy is an economy that creates low carbon emissions, minimizes negative impacts on the living environment; effectively uses resources such as converting to renewable energy, using clean technologies in production and management of economic sectors; ensure social justice.

2.2.2. Characteristics and roles of green economy

Based on widely recognized views on green economy, there can be synthesized into the following basic characteristics: (1) green economy creates conditions for sustainable development; (2) contributes to save resources and energy; develops clean technology and reduces carbon emissions; (3) respects for planetary boundaries, ecological limits or scarcity; (4) measures economic progress beyond GDP using appropriate indicators or metrics; (5) brings equality, fairness and justice between nations and between generations; (6) protects biodiversity and global ecosystems; (7) pays attention to social issues that contributing to poverty reduction, improving living standards, ensuring sustainable livelihoods, creating more green jobs, social protection and accessing to essential services; (8) improves governance and the rule of law including democracy, community participation, accountability and stability.

According to the Institute of Strategy and Policy on Natural Resources and Environment (2011), with the above basic characteristics, in the process of national sustainable development, the green economy has the following roles:

Firstly, the green economy contributes to poverty reduction: Moving towards a green economy is a method to reduce poverty and improve the overall quality of life. In a green investment scenario, 2% of global GDP is allocated to “greening” the energy, transport, construction, waste, agriculture, fisheries, water and forest sectors. The green economy provides energy sources capable of supporting the 1.4 billion people who currently lack electricity and more than 700 million others who do not have access to modern energy services. Renewable energy technologies such as solar energy, wind energy and energy support policies promise to contribute significantly to improving the lives and health of a low-income population, especially for those who currently do not have access to energy.

Secondly, the green economy mitigates climate change: According to calculations, only about 1.25% of global GDP has been invested in improving efficiency and developing renewable energy, including biofuels, second generation, worldwide energy consumption could be reduced by 36% in 2030 and annual CO_2 emissions would decrease from 30.6 billion tons in 2010 to 20 billion tons in 2050. Therefore, by using green agriculture, the green economic scenario is estimated to reduce greenhouse gas concentrations to 450 ppm in 2050. A reasonable and sufficient level could limit global warming to 2^oC.

Thirdly, green economy maintains and enhances natural capital: According to UNESCO (2011), green investments in the forestry and agricultural sectors will help reverse the current trend of forestland decline. About 4.5 billion hectares of this important resource could be regenerated within the next 40 years. Investing in green agriculture both improves productivity, produces more foods and helps to reduce the amount of land used for agriculture and livestock by 6% and improves agricultural land quality by 25% in 2050. In addition, investment to increase water supplies, expand access as well as improve management will provide 10% more global water supply both in the immediate and long term.

3. Results

3.1. Situation of green economic development in Vietnam

Over the past two decades, Vietnam has been severely affected by climate change, arable land degradation, storms and floods, and one of the fundamental causes comes from the decline in forestry. In fact, Vietnam has implemented many activities related to sustainable production and consumption, in which green consumption is receiving more and more attention. Many related documents have been signed such as: International Declaration and National Action Plan on Sustainable Production and Consumption (1999), legal documents related to protecting consumer rights; Law on economical and efficient use of energy; International Declaration on cleaner production (1999). Programs related to green products such as programs for granting eco-labels, energy-saving labels, and eco-labels for the tourism industry are also implemented. In particular, the National Strategy on green growth for the period 2011 - 2020 and vision to 2050 is an important legal basis for developing policies related to green consumption in Vietnam in the coming period. The orientation and goals of greening the economy are shown in detail in Decision No.1393/QDTTg dated September 25th, 2012 by the Prime Minister that approving the National Strategy on green growth for the period 2011 - 2020 and vision to 2050. This is the first comprehensive national strategy in the field of green economic development in Vietnam.

Due to the correct policies of the Party and State, and the direction of the government through each stage, the implementation of green economy in Vietnam has achieved a number of remarkable achievements. Table 1 shows that Vietnam's economic growth rate remains at an average level of about 6.07%/year in the period from 2010 - 2022. Vietnam is continuing its innovation momentum, promoting the transformation of growth model in depth, quality and efficiency, and doing best to recover post-Covid-19. Vietnam's economy has shown significant resilience in times of crisis, most recently the Covid-19 pandemic, GDP growth decreased to 2.55% in 2021 due to the emergence of the Delta variant but there was a recovery in growth to 8.12% in 2022.

Table 1: GDP and economic growth rate of Vietnam in 2010 - 2023

Year	GDP at constant prices in 2010 (billion VND)	Economic growth rate (%)
2010	2.739.843,17	
2011	2.915.553,94	6,41
2012	3.076.041,91	5,50
2013	3.246.870,23	5,55
2014	3.455.392,13	6,42
2015	3.696.825,71	6,99
2016	3.944.143,68	6,69
2017	4.217.874,76	6,94
2018	4.532.739,40	7,47
2019	4.866.315,60	7,36
2020	5.005.755,65	2,87
2021	5.133.589,06	2,55
2022	5.550.616,91	8,12
2023 estimated		5,05

Source: General Statistics Office

Vietnam's economic structure in 2023 is mainly contributed by the service and industrial sectors. Compared to previous years, Vietnam's economic structure in 2023 has a shift in a positive direction, that increasing the proportion of industry and services, gradually decreasing the proportion of agriculture, forestry and fisheries, this trend consistent with the Government's green economic development orientation.

During more than 10 years of implementing the green economy, with the direction of the Party and State along with the social community's awareness of the importance of green economy, up to now, the economy has made outstanding progress. Production and consumption behaviors have changed significantly and improved positively. There are more and more practical actions contributing to green economic development. People's lives are constantly being improved and enhanced, many urban areas have emerged, especially new rural areas have been formed.

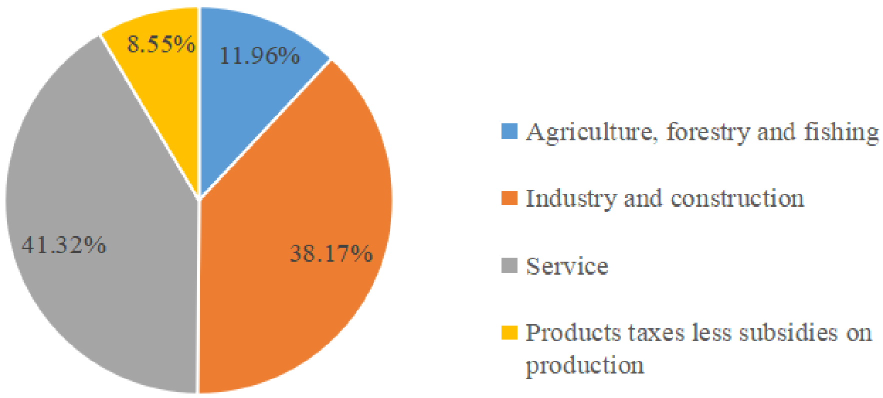

Figure 1: Vietnam's GDP structure in 2023

Source: General Statistics Office

Green economic development has had a positive impact on domestic labor, and Vietnam's labor structure has a clear tendency to shift towards non-agriculture. Table 2 shows that the proportion of workers working in agriculture, forestry and fishing decreased from 48.6% of the total number of employed workers in the economy in 2010 to 27.54% in 2022. At that time, the proportion of workers working in industry, construction and service increased to 33.45% and 39.02% respectively in 2022. This trend is consistent with the goal greening the economy, that contributes to supplementing and developing high-quality human resources for applying the achievements of the fourth industrial revolution to national economic development.

Table 2: Structure of employed labors by economic sectors (%)

Sectors	2010	2015	2016	2017	2018	2019	2020	2021	2022
Agriculture, forestry and fishing	48,6	43,6	41,6	40	37,6	34,5	33,06	29,06	27,54
Industry and construction	21,8	23	25,2	26,3	27,3	30,2	30,79	33,11	33,45
Services	29,61	33,41	33,2	33,71	35,11	35,31	36,15	37,83	39,02

Source: General Statistics Office

To achieve initial achievements in the goal of greening the economy, the Government must play an important role in actively supporting and creating conditions for domestic businesses to keep up with domestical and international market developments, thereby improving their competitivenesss. In addition, State agencies also offer many measures to encourage businesses to approach and apply green agriculture models, develop green industry, develop renewable energy, save energy and reduce CO2 emissions in heavy industries.

In addition, Vietnam has always received the companionship and active support of organizations such as the World Bank, Asian Development Bank... in the process of developing green economy in many fields, especially the investment in projects on green industry, green energy, infrastructure development, urban environmental management and response to climate change.

3.2. Problems

Besides the positive results achieved, green economic development in Vietnam still has some of the following limitations:

Firstly, the data in Figure 2 shows that the amount of Vietnam's CO2 emissions in 2022 is 327,906 thousand tons, that decreased to 9,784 thousand tons, with a growth rate of -2.9% compared to 2021, while the amount of CO2 emissions in the first year of implementing the green growth strategy (2011) was only 157,066 thousand tons. This amount of CO2 emissions has put Vietnam in the ranking of 184 in the most polluting countries in the world in 2022. In general, CO2 emissions in Vietnam during the period 2010 - 2022 tended to increase significantly, the figure in 2022 was double than in 2010. On the other hand, according to analysis by Countryeconomy.com (2022), the ratio of CO2 emissions per 1,000 USD of GDP will measure the "environmental efficiency" of a country over time. As a result, in the period 2010 - 2022, this number in Vietnam tended to raise, from 0.28kg to reach the peak of 0.34kg in 2019 and 2020, then gradually decreased to 0.29kg per 1,000 USD of GDP in 2022. This shows that the promotion of green economic development in recent times has increased the demand for energy consumption, meaning that CO2 emissions tend to increase rapidly.

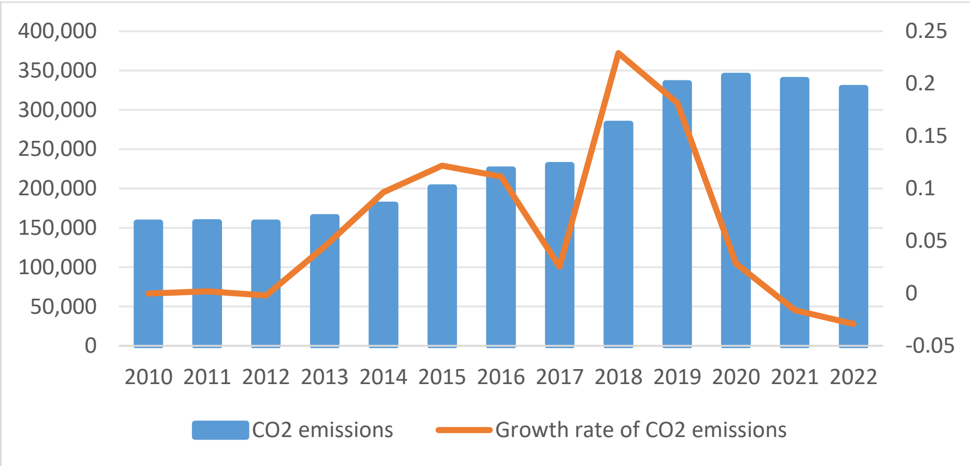

Figure 2: Growth rate of CO_2 emissions in Vietnam in 2010 - 2022

Source: Author

Secondly, financial resources for the goal of greening Vietnam's economy are still quite limited in the context of a limited state budget and the severe impact of the Covid-19 pandemic. Besides, fluctuations and instabilities from the world economy have had a significant impact on Vietnam's macro economy. These events make Vietnam's economic recovery process more difficult and pose many risks, that requires the policymakers not only to ensure sustainable development goals but also to overcome the difficulties ahead.

Thirdly, the quality of labor resources for the green economy in Vietnam does not meet the requirements of high scientific and technological level of the green economic development strategy. Compared to the world, production lines and technology in Vietnam are largely old and outdated, consuming a lot of fuel and energy. Therefore, applying modern production lines and advanced technology to the green economy is a big challenge for Vietnam, requiring high-quality human resources to undertake it. In addition, the restructure of labor is still slow and cannot keep up with the restructure of economy (Nguyen, 2021).

Fourthly, although the Government has issued and approved national strategies on green growth and sustainable development according to each period, the legal system is still not truly synchronized, and there are no documents that regulating specificly on green energy and renewable energy. It is necessary to promulgate new laws on industrial development and environmental protection. In addition, the management and implementation of green economic development strategies in sectors, regions and localities across the country are not truly linked and unified.

4. Implications

Vietnam needs to implement some of the following solutions to develop a green economy associated with sustainable development of the country in a comprehensive way, not only achieve economic growth goals but also ensure social security, environmental protection and ecosystem for the future.

Firstly, raise awareness of both the political system and people about environmental protection. Propagating and educating about the environment is an important job, from which to take practical actions in restoring ecosystems, preserving biodiversity, preventing climate change... Each person contributes to improving the effectiveness of strategies, programs and action plans that the Government has proposed, moved towards a green economy, green and sustainable development.

Secondly, the investment environment should be improved, attract all resources from all economic sectors, with a focus on mobilizing foreign capital. Attracting foreign capital not only contributes to green economic development but also helps domestic businesses learn from foreign enterprise's experiences. Regarding the financial mechanism for green growth at the local level, it is necessary to clearly decentralize central and local financial capital sources for green growth as well as diversify forms of attracting and mobilizing finance for green growth, such as issuing green bonds in localities. In addition, it is necessary to build institutions to encourage the response and participation of society, especially businesses and people, to further strongly promote public-private projects in green growth; form new value chains and industries through greening agricultural and industrial production and services. Environmental policies need to be reformed, the systems of natural resources tax and environmental tax need to continue to be researched to adjust and perfect.

Thirdly, there should be increasing investment in science and technology, at the same time, receiving and transfering advanced technology suitable to Vietnamese conditions, promoting research in green economic development fields, and promulgating mechanisms to encourage and promote research used new technologies, such as reducing carbon emissions, developing renewable energy and environmentally friendly energy. In addition, research and application of science and technology should be promoted, because this is an important content in establishing theoretical, scientific and practical bases to build mechanisms, policies, and management methods, contribute actively to forecasting, preventing, renovating, restoring, treating environmental pollution and preserving biodiversity.

Fourthly, it is necessary to uphold responsibility to the community, respect for the common interests of all humanity, ensure an international environment of peace, stability, cooperation and development, strengthen international cooperation in projects towards green economic development. As a country with limited economic potential, Vietnam cannot go alone but should take advantage of international opportunities and develop to suit Vietnam's context and conditions. Therefore, Vietnam needs to expand cooperation with important partners such as Japan, Germany, EU... towards green growth strategy and global commitments in the coming time. Besides, Vietnam also promotes green exports in the new context, associated with a strong transition to a green economy and green development worldwide.

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Status of Green Economy Implementation in Vietnam - Suggested Solutions towards Sustainable Development Goal

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Abstract

Green economy is one of the important factors helping Vietnam develop sustainably in the future. The article has clarified the concept, role and content of green economic development for the purpose of sustainable development. At the same time, it analyzes and clarifies the current status of green economic development in Vietnam through the contents of green industry, green agriculture and green services, especially the Party and State's policy on green economic development. The results show that, although many achievements have been made, the process of developing the green economy in Vietnam still has limitations that need to be further addressed. On that basis, the article suggests some solutions to develop the green economy in Vietnam for the purpose of sustainable development in the context of digital transformation.

Keywords: *Green economy, solutions, environmental goals, sustainable development*

1. Introduction

In the context of globalization and the rapid development of technology, the green economy has become an important trend not only in the world but also in Vietnam. “Recently, the Government has encouraged green growth in economic and social fields towards sustainable development of the country, especially in the agricultural sector” (Nguyen et al., 2022, 39). This is a sustainable economic development model, ensuring a balance between economic growth, environmental protection and social equity. The green economy is understood as an economic system that focuses on reducing emissions, rationally using natural resources, and aiming to improve the quality of human life. In recent years, Vietnam has made significant progress in pursuing this development model. The Vietnamese government has introduced many policies and strategies to promote the green economy, typically the national green growth strategy and the national action plan on climate change. However, the implementation of the green economy still faces many challenges, including inadequate social awareness, limited policy mechanisms, and outdated technological infrastructure. “The economy is facing increasing environmental issues, which may affect long-term economic development and the goal of putting Vietnam on the path to prosperity and higher economic growth in the future” (Huynh, 2023).

Up to now, there have been a number of studies on the current status of green economic development in Vietnam such as: "*Green economic development: International experience and lessons for Vietnam*" by Doan Thi Cam Thu published in Banking Magazine; "*Green economic development in Vietnam*" by Nguyen Quang Huy published in Finance Magazine; "*Experience in developing green industrial policies in some countries and lessons for Vietnam*" by Phung Thi Quynh Tranh published in Environment Magazine. These studies have clarified the role of green economic development in general, some studies have clarified the current status and proposed solutions for green economic development from certain perspectives. However, there has not been a comprehensive study on green economic development from all perspectives from the viewpoints and policies of the Party and State on green economic development to the sectoral structure of the economy (including industry, agriculture and services). Therefore, this study continues to contribute to clarifying the current status of green economic development in Vietnam from many different perspectives to provide a comprehensive picture of Vietnam's green economy. From there, it suggests some solutions to develop the green economy towards the goal of sustainable development in Vietnam in the context of digital transformation.

2. Theoretical framework

According to the United Nations, “Green economy is an economy that brings a new economic growth model that is friendly to the earth's ecosystems and contributes to solving the employment problem for workers. Based on the economic production foundation, green economy helps to reduce emissions, reduce resource consumption and reduce environmental costs” (Matthews, 2022). Frone & Simona (2015) stated that “The green economy can also be understood as a dynamic economic transformation, with the goal of low carbon, increasing the efficiency of resource use and increasing people's welfare by using technology and creating new jobs, while minimizing environmental degradation in the long term” (Frone & Simona, (2015). “A green economy is an economy that improves human life and improves social equity, while significantly reducing environmental risks and ecological deficiencies. Simply put, a green economy has low emissions, uses resources efficiently and aims for social equity” (Vu, 2015). Thus, a green economy is a model of sustainable economic development, which focuses on the efficient use of resources, minimizing greenhouse gas emissions, and minimizing negative impacts on the environment, while contributing to improving the quality of life improve human life and well-being while promoting social equity through the creation of new job opportunities. In addition, the green economy aims to protect ecosystems and address long-term environmental challenges, through the application of advanced technology and environmentally friendly production methods.

The International Union for Conservation of Nature and Natural Resources (IUCN) defines: "Human development cannot only focus on economic development but must also respect the essential needs of society and the impact on the ecological environment" (UNIDO, 2002). According to Pham Thi Nga and colleagues, "Sustainable development is a method of socio-economic development that aims to properly resolve the relationship between economic growth, solving social problems and protecting the environment with the goal of better meeting the needs of the current generation while not hindering the meeting of the needs of future generations" (Pham, 2018, 95). In Section 4, Article 3 of the Law on Environmental Protection defines: “Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet those needs on the basis of closely and harmoniously combining economic growth, ensuring social progress and environmental protection”. Thus, sustainable development is a long-term stable development solution in one or many different fields that are related to each other, such development is associated with the good and harmonious resolution of the relationships between economic growth and social and environmental issues (natural environment and social environment).

In short, sustainable green economic development is the process of promoting economic growth based on the efficient use of resources, minimizing greenhouse gas emissions and negative impacts on the environment, while ensuring a balance between economic development, environmental protection and social equity. This process not only creates many new job opportunities and improves human welfare, but also aims to protect the ecosystem and solve long-term environmental challenges. Sustainable development is a harmonious combination of economic growth and social and environmental factors, to ensure long-term stability and sustainability for both natural and social ecosystems.

3. Methods

Data collection method: The study uses data collected from published documents such as publications in specialized journals, documents related to economic development in general, green economy in general (including industrial development, green agriculture and green services), on that basis effectively inheriting previous research results to continue developing green economic development research towards the goal of sustainable development.

Data analysis method: The author describes and analyzes the collected data to clarify the picture of the current status of green economic development in Vietnam in terms of the viewpoints and policies on green economic development of the Party and State of Vietnam; green industrial development; green agricultural development; green service development. On that basis, suggest solutions to develop the green economy with the goal of sustainable development in the context of digital transformation.

4. Results

4.1. Vietnam's GDP growth rate and economic structure

Green economy plays an important role in sustainable development. "Green economy considers environmental resources as the foundation for economic growth, development and improving the quality of human life" (Do, 2018, 8). "Adapting to changes in the context of changing development related to increasingly deep international economic integration and responding to the impacts of climate change" (Do, 2014). Thus, it can be affirmed that: (1) Green economy considers natural resources and environment as the foundation for economic growth. Instead of exploiting exhausted resources, green economy focuses on the rational use and protection of environmental resources to ensure long-term development; (2) Green economy sets limits for enhancement based on the carrying capacity of environmental resources, that is, only when a certain threshold of resources and environment is reached, economic activities can continue without causing great damage to the ecosystem; (3) Improve the quality of life through creating sustainable development solutions, focusing not only on economic growth but also on the environment and welfare.

Table 1: Vietnam's GDP growth rate in the period in 2016-2023

Year	2016	2017	2018	2019	2020	2021	2022	2023
GDP Growth (%)	6,99	6,94	7,47	7,36	2,87	2,55	8,12	5,05

Source: General Statistics Office

The results are shown in Table 1 and Table 2, showing that there is growth in GDP and the economic structure of the industrial and construction sectors, with services accounting for a higher proportion, contributing to sustainable development and reducing environmental pollution.

Table 2: Vietnam's economic structure by GDP in 2023

Sectors	Proportion (%)
Agriculture, forestry and fisheries	11,96
Industry and construction	37,12
Services	42,54

Source: General Statistics Office

Aspects of green economic development focus on achieving economic, social and environmental sustainability including: Optimizing the use of land, water and energy to minimize waste and environmental degradation; Encouraging businesses to shift to less polluting production processes, using renewable energy and efficient waste management; Creating employment opportunities and promoting industries such as renewable energy, organic agriculture, and ecotourism; Ensuring equitable allocation of resources and benefits, especially for vulnerable groups; Protecting and restoring natural ecosystems to maintain environmental balance; Encouraging technological innovation to improve resource efficiency and reduce pollution; Commitment from the government through policies and regulations to promote sustainable development. Thus, green economic development not only includes environmental issues but is also closely related to economic, social and policy aspects, requiring close cooperation between the government, businesses and people towards a sustainable economy, protecting resources and improving the quality of life.

4.2. Current status of green economic development in Vietnam

4.2.1. Party and government policies on green economic development

The State has issued regulations and policies to guide the development of a green economy in Vietnam, specifically:

The Government (2012) affirmed: “Green growth is an important content of sustainable development, ensuring rapid, effective, sustainable economic development and making an important contribution to the implementation of the National Strategy on Climate Change” (Government, 2012). This is the first comprehensive national strategy on green economic development in Vietnam.

The 13th National Party Congress affirmed: “Continue to develop the country rapidly and sustainably, ensure macroeconomic stability, strongly innovate the growth model, improve productivity, quality, efficiency and competitiveness of the economy. Proactively and effectively adapt to climate change, manage, exploit, use resources rationally, economically, effectively and sustainably; take protecting the living environment and people's health as the top goal; resolutely eliminate projects that cause environmental pollution, ensure the quality of the living environment, protect biodiversity and ecosystems; build a green economy, a circular economy, and an environmentally friendly economy” (Communist Party of Vietnam, 2021).

In addition, the Government, ministries, branches and localities have issued many legal documents, such as: Decision No. 2139/QD-TTg dated December 5, 2011 approving the National Strategy on Climate Change; Decision No. 1474/QD-TTg promulgating the National Action Plan on Climate Change for the period 2012 - 2020 to realize the tasks of the Strategy; Decision No. 622/QD-TTg dated May 10, 2017 promulgating the National Action Plan to implement the 2030 Agenda for Sustainable Development; Decision No. 1670/QD-TTg dated October 31, 2017 approving the Target Program on Climate Change Response and Green Growth for the period 2016 - 2020; Decision No. 1658/QD-TTg dated October 1, 2021 approving the National Strategy on Green Growth for the 2021-2030 period, with a vision to 2050.

Thus, Vietnam has issued many policies and legal documents to promote sustainable green economic development. The Government has affirmed that green growth is an important factor in the national sustainable development strategy, while emphasizing the role of business in ensuring rapid and effective economic development, adapting to climate change. In general, legal documents have partially met the requirements for developing a green economy in the context of digital transformation.

However, the development of these policies still faces many challenges such as lack of resources, inadequate infrastructure, and limited rational distribution among local means. “However, the legal system for environmental protection does not have a close, organic connection between regulations on economic development and regulations on environmental protection. Regulations are still heavy on formality without paying attention to the content of practical implementation” (Nguyen, 2023). Although there are many legal documents, effective implementation still needs to be improved to achieve sustainable green development goals.

4.2.2. Green industry

Green industry development in Vietnam is increasingly focused on in the context of the country moving towards a sustainable economic model. Green industry, focusing on efficient use of resources, reduction of pollution and emissions, has become an important goal in Vietnam's development strategies. The State has implemented many policies such as the National Green Growth Strategy, Renewable Energy Development Plan and emission reduction programs. Priority is given to areas such as renewable energy, clean production and environmental technology. In addition, many businesses have begun to apply advanced technologies to reduce energy and resource consumption and provide cleaner products.

“Currently, the proportion of operating renewable energy accounts for nearly 27% of the total installed capacity of the entire system. To implement the Net-Zero commitment at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 26), Vietnam has determined to strongly develop this type of energy until 2030 and 2050. The Power Plan VIII approved in May 2023 is expected to increase the capacity of solar power sources by 4,100 MW by 2030, reaching 168,594 - 189,294 MW, producing 252.1 - 291.5 billion kWh by 2050; It is expected to develop 21,880 MW of onshore wind power, 6,000 MW of offshore wind power by 2030 and 70,000 - 91,500 MW by 2050" (Nguyen, 2022). Thus, the State pays great attention to investment in the field of renewable energy. However, this process still faces many challenges such as high investment capital, lack of infrastructure and unreasonable coordination between departments. The transition to green industry requires synchronous implementation of both the public and private sectors in terms of both policy and finance. Although there are many regulations, the development of green companies in Vietnam still has potential, especially when the country is committed to achieving sustainable development goals and reducing greenhouse gas emissions as committed, but still faces many challenges, especially in terms of environmental issues. "According to experts' forecasts, Vietnam's CO_2 emissions will reach nearly 471 million tons by 2030. Every year, Vietnam generates about 1.83 million tons of plastic waste; every day, the amount of domestic solid waste generated is about 61,000 tons, of which up to 71% of the total waste (equivalent to 43 thousand tons/day) is treated by landfill; many resources are currently seriously depleted" (Hoang, 2024).

The application of technology in green industrial development has also increased. "In the period of 2011-2022, the trend of developing green industry, green and clean production has become popular in Vietnam. The rate of industrial enterprises applying cleaner production technology increased from 11% to 32% in the period of 2011-2015, in which the rate of establishments reducing energy, raw materials and fuel consumption per unit of product thanks to the application of cleaner production technology increased from 11% to 24%" (Bui & Nguyen, 2023).

The export of high-tech industrial products also tends to increase. "In the restructuring of the industrial sector in the period 2016 - 2020, the proportion of the mining industry gradually decreased while the proportion of the processing, manufacturing and high-tech application sector increased. The proportion of the export value of high-tech products in the value of high-tech products increased sharply from 26.9% in 2010 to 78.3% in 2020. The proportion of the processing and manufacturing industry in GDP increased from 13.4% in 2016 to 16.7% in 2020" (Communist Party of Vietnam, 2021, 21).

4.2.3. Green agriculture

This is an economic sector that plays an important role in the national economy. "Agriculture has made a strong shift to commodity production, applying high technology, improving quality and efficiency, continuing to be the pillar of the economy; the rural economy continues to develop; the new rural construction program has achieved many important results, completed nearly two years ahead of schedule, contributing to changing the face of the countryside and farmers' lives" (Communist Party of Vietnam, 2021, 61-62). Thus, the trend of applying technology in agricultural production in Vietnam is increasingly focused on, contributing to improving production efficiency and protecting the natural environment.

The green trend in farming in Vietnam is growing, the application of biotechnology, organic fertilizers and advanced farming techniques helps improve crop productivity, while protecting the environment and human health, minimizing the use of agricultural chemicals, protecting soil and water resources, thereby reducing negative impacts on the ecosystem. Organic agricultural production meets the increasing consumer demand for clean, safe and sustainable products, creating opportunities for Vietnam to expand its agricultural export market. "The trend of developing green agriculture with biotechnology, biological fertilizers, applying advances in farming and research on new varieties and intensive farming skills to increase crop and livestock productivity, while ensuring green values for the environment and safety for humans. Vietnam aims to develop green, environmentally friendly agriculture by 2030, adapt to climate change, reduce rural environmental pollution, and strive to reduce greenhouse gas emissions by 10% compared to 2020" (Vu et al., 2024). However, this trend also faces many limitations such as high investment costs for green technology and organic fertilizers, causing difficulties for small-scale farmers. Moreover, the scale of organic agricultural production in Vietnam is still small, lacking policy and technical support, along with limited market access, reducing the effectiveness of green agricultural development.

The trend of producing and exporting organic agricultural products is also an important point that is being focused on investing in Vietnam today. Vietnam has set a big goal in this field, reflected in its long-term strategy. "GDP growth rate of the agricultural sector is 2.5 - 3%/year; improving the efficiency of using and protecting the country's resources, fisheries, forests, and biodiversity conservation; forest coverage is maintained at 42%, the area with sustainable forest management certification is over 1 million hectares; reducing the intensive use of agricultural chemicals and increasing the efficiency of using natural resources in the agricultural production process" (Nguyen, 2023). However, the market share of Vietnam's organic agricultural products in the international market is still small, and the great potential sources of Vietnamese agriculture such as weather, land, water resources, etc. have not been fully exploited.

Thus, green agriculture in Vietnam is developing with many achievements, especially fully meeting the domestic demand for agricultural products. However, there are still limitations in international export markets, especially green development in agriculture to promote sustainable development.

4.2.4. Green services

Green services include activities such as eco-tourism, eco-friendly hotels, clean transportation services, along with pioneering businesses in minimizing environmental impacts through waste management, energy saving and the use of recycled materials. The outstanding advantage of the green service sector is its ability to contribute positively to greenhouse gas emission reduction, helping Vietnam fulfill its international commitments such as the Net-Zero target by 2050, attracting international tourists. "Specifically, by the end of 2019, international tourists to Vietnam were about 18 million, domestic tourists were about 80 million, the number of domestic tourists has grown strongly in recent years" (Communist Party of Vietnam, 2021, 25).

Vietnam has made remarkable achievements in greening chemistry and digitalizing specialized services. E-commerce is one of the sectors with outstanding growth, playing an important role in the process of economic transformation towards sustainability. In addition, the green logistics sector is also receiving attention through the application of digital technology to optimize operations, storage and order management processes. "Vietnam has achieved many encouraging results in the process of digitalizing and greening the Service industry, especially the strong development of e-commerce with an average growth rate of 16-30%/year in nearly a decade. The green logistics sector is associated with the digital transformation process to optimize processes and models of transportation management, orders, and warehouses" (Vu et al., 2024).

Promoting green economic development has also contributed to stabilizing Vietnam's economic growth rate in recent years, even in the face of many challenges from outside. The State has had many policies to encourage investment in areas such as agriculture, modern technology and renewable energy, helping to restructure the economy positively. "In fact, in recent times, Vietnam has achieved many encouraging results in the process of digitalization and greening the service industry" (Nguyen, 2023). This shift also helps change the labor structure in a more sustainable direction, with an increase in labor in the industrial and service sectors, gradually replacing agricultural labor.

However, the development of green services in Vietnam still faces many challenges. "The awareness of Vietnamese people and businesses about the green economy is still limited" (Nguyen, 2023). One of the biggest barriers is the high initial investment cost, along with the limited awareness of businesses and users about green services. The lack of incentive mechanisms and policy support tools can also be a barrier to the expansion of this sector.

4.3. Solutions to promote the development of a green economy with the goal of sustainable development in Vietnam in the current context of digital transformation

In the context of global digital transformation and environmental formulas, developing a green economy in Vietnam is an essential requirement. To achieve sustainable development goals, comprehensive solutions in law, industry, agriculture, services and human resource training need to be implemented synchronously.

First, continue to improve the legal system and effective enforcement measures

In the context of digital transformation, a complete legal system related to the green economy is a necessary factor to promote sustainable development. Therefore, it is necessary to implement solutions: First, Vietnam needs to continue to update and amend regulations to support production, business and consumption activities in an environmentally friendly direction. One of the first steps is to develop policies to support businesses in transforming into green business models and applying environmental standards. Second, incentive solutions such as tax exemption or reduction for businesses that comply with environmental protection standards, along with the development of financial support programs to promote green production are feasible options. In addition, it is necessary to improve the monitoring and inspection of the implementation of regulatory solutions, especially in the management of natural resources and emissions from production products. Third, synchronization in the legal system across sectors and fields is essential to create a favorable business environment, not only helping businesses comply with environmental protection standards but also providing international cooperation, especially when foreign businesses tend to prioritize countries with stable and serious environmental policies.

Second, green industrial development

Green industrial development plays an important role in providing a green economy, while contributing to minimizing negative impacts on the environment. “Vietnam's industrialization and modernization process is taking place in the context of increasingly evident impacts of climate change, so greening existing industries is considered a necessary task and the key to mitigating climate change, towards green growth and sustainable development. With green industrial development policies and renewable energy that are effective in economic growth, solving social and environmental problems in other countries, Vietnam can learn to apply them to real conditions” (Phung, 2021). To promote green industry, Vietnam needs to pay attention to developing clean and environmentally friendly production technologies, improving product manufacturing processes to optimize the use of raw materials and

Enterprises need to invest in research and development of advanced technological solutions, consider limiting the use of renewable energy (wind, solar, hydropower) in production, or apply circular economic models to optimize the regeneration and reuse of raw materials. At the same time, encourage enterprises to apply environmental management systems such as ISO 14001 to ensure environmentally friendly production processes.

For traditional industries such as textiles, wood processing and food, it is necessary to demonstrate the transition to a green production model, using fewer resources and reducing CO2 emissions to a minimum. The State needs to introduce policies to encourage and support businesses to invest in new technologies, reduce costs and create conditions for these businesses to access green capital sources.

Third, green agricultural development

Agriculture is one of the important sectors that contributes greatly to the Vietnamese economy. However, the excessive use of chemical fertilizers and pesticides, along with the development of forests to expand the cultivated area, is causing many environmental problems. Developing green agriculture is not only a solution to protect the environment but also helps to improve the productivity and quality of agricultural products.

An important solution is to strongly apply biotechnology to agricultural production. This technology helps to minimize the use of chemicals, increase the sustainability of the agricultural ecosystem, and at the same time improve product quality. In addition, applying organic farming models, combined with measures to protect and regenerate the soil, will help maintain and develop a sustainable soil ecosystem.

Changing the structure of crop and livestock farming to suit natural conditions and adapt to climate change is also an important solution. This helps optimize the use of water resources, minimizing dependence on natural resources such as water and land. At the same time, supporting financial support programs and training for farmers in applying new, environmentally friendly farming techniques is essential to promote green agriculture.

Fourth, green tourism development

Green services include activities that provide environmentally friendly products and services, contributing to reducing energy consumption, greenhouse gas emissions and protecting natural resources. In Vietnam, green services have great potential for development, especially in the tourism and logistics sectors.

For the tourism industry, developing a sustainable and eco-tourism model is one of the leading solutions. This not only helps protect the environment but also enhances the cultural and historical values of localities. Tourist areas need to pay attention to protecting natural ecosystems, while encouraging visitors to participate in environmentally friendly activities such as planting trees and protecting forests.

In the logistics sector, developing transportation services using renewable energy and reducing the use of fossil fuel-consuming vehicles is an important solution. Starting to use electric vehicles and underground discharge stations will help reduce CO_2 emissions, the contribution

Fifth, explain the method of labor restructuring

In the context of many traditional industries being co-opted by environmental protection requirements, the transformation of the labor structure is an important factor in the development of the green economy. To ensure that the process of transformation is shared, Vietnam needs a specific strategy to restructure the labor structure, helping workers to transition to new occupations related to the green economy, such as renewable energy, environmental technology.

Reskilling workers is a necessary solution, including short-term training programs and intensive training courses to help them adapt to the requirements of the new labor market. At the same time, there is a need for cooperation between businesses, governments and non-governmental organizations in developing programs to support workers in changing careers to ensure social security and secure employment opportunities.

The government needs to introduce financial support policies and encourage businesses to invest in green sectors, creating more jobs for workers in this sector. Social and biological welfare policies must also be taken into account so that workers can feel secure during the restructuring process. Connecting workers with new industries will contribute to promoting the development of a green and sustainable economy.

Fifth, solutions to train high-quality human resources

Vietnam needs to develop synchronous measures to improve training quality and meet labor market needs in green economic development sectors.

First, the education and training system needs to be reformed to focus on green economy-related occupations. Universities and colleges should develop modern curricula that integrate knowledge of green technology, renewable energy and environmental management. Close cooperation with businesses is needed to ensure that courses are tailored to practical needs, helping graduates quickly apply their knowledge to real-world work.

Upskilling the current workforce is crucial. Vocational training programs and short courses need to be developed to help workers update their skills and access new technologies in the green economy. This will not only improve work efficiency but also help workers adapt to new demands.

Special attention should be paid to continuous training for managers and professionals to keep them updated on new trends and technologies. The government should consider developing financial support policies and sponsored learning to encourage the development of high-quality human resources in green fields.

5. Conclusion

Green economy is not only an inevitable trend of global development but also an urgent requirement for Vietnam in the context of increasingly serious climate change and environmental degradation. Although Vietnam has taken specific steps in building the foundation for a green economy through national strategies and policies, the journey towards sustainable development goals still faces many challenges such as unsynchronized policy mechanisms, lack of financial and human resources, and the scarcity of advanced technological solutions. The article presents an overview of the green economy in Vietnam, clarifying the progress and limitations in developing the green economy. From there, a number of solutions have been suggested to enhance the effectiveness of the green economic model for sustainable development in the context of digital transformation. Only green economic development is a sustainable strategic solution that not only helps Vietnam develop but also contributes to enhancing the country's position in the international arena. If solutions are implemented in the right direction and effectively, the green economy will be the main driving force for Vietnam to achieve its environmental, economic and social goals in the coming decades.

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A Study on the Factors Influencing the Adoption of Circular Economy Practices by Manufacturing Enterprises in the Nguyen Khe Industrial Cluster, Dong Anh district, Hanoi

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Abstract

This study was conducted to identify the factors affecting the effectiveness of circular economy applications in enterprises within the Nguyen Khe Industrial Zone, Dong Anh District, Hanoi. The research involved surveys of 145 operational processes in industrial enterprises across five different sectors within the Nguyen Khe Industrial Zone. Through analytical steps using SPSS 20.0 and Amos 20.0 software, the research team cleaned the data in sequence, performing descriptive statistics, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and developing a structural equation model (SEM). The results indicate that six factors influence the adoption of circular economy practices in enterprises: maintaining natural capital, product life cycle management, the use of policy tools, management awareness, employee awareness, and community responsibility.

Keywords: *Circular economy, enterprises, capital, product life cycle, policy, management, employees, responsibility*

1. Introduction

The circular economy is an economic model where design, production, and service activities aim to extend the lifespan of materials and eliminate negative impacts on the environment. While the linear economic model focuses solely on resource extraction, production, and disposal after consumption - leading to the generation of a massive amount of waste - the circular economy emphasizes the management and regeneration of resources in a closed loop, with the goal of preventing waste creation. Resource utilization is achieved through various means such as repair, reuse, recycling, and shifting from material ownership to sharing or renting. Awareness of the role of the circular economy is widely recognized today by many countries and international organizations as "a restorative and regenerative system by design. It replaces the concept of 'end-of-life' of materials with restoration, shifts towards renewable energy, avoids harmful chemicals that hinder reuse, and aims to minimize waste by designing materials, products, systems, and business models within that system" (Ellen MacArthur Foundation, 2012). Thus, the circular economy can be seen as a system where resources are reclaimed or reused, and waste streams are transformed into inputs for continued production. Rapid urbanization, climate change, technological advancements, and the growing demand for finite natural resources have driven this activity.

The circular economy is often associated with sustainable development and holds significant importance for environmental management, helping businesses save energy, reduce costs, and protect the environment. Sustainable development and the circular economy offer global-level benefits, including: optimizing material use, generating new and innovative income streams, enhancing stakeholder relationships and brand reputation, and minimizing risk. Many economic experts believe that the reprocessing of goods and materials creates jobs and saves energy, while simultaneously reducing resource consumption and waste generation. Thus, the circular economy is understood as a closed-loop production cycle, where waste is reintegrated as raw material for production, thereby minimizing any negative environmental impact and safeguarding ecosystems and human health. The circular economy operates as a closed system, wherein everything generated during production is utilized through sorting, reuse, and recycling. This model is superior in that it eliminates waste creation, with the broader goal of coupling economic growth with environmental protection, ultimately aiming for sustainable development.

Vietnam is rapidly integrating deeply into the global economy, especially through participation in bilateral and multilateral free trade agreements, including next-generation free trade agreements. Most of these agreements contain provisions and commitments related to sustainable development, environmental protection, climate change response, and compliance with waste and emission standards. This serves as a foundation for accelerating Vietnam's transition to the circular economy model. Researching the factors influencing the application of the circular economy in industrial clusters and parks in Vietnam today will assist businesses in learning practical experiences from developed nations regarding economic model development, while capitalizing on opportunities for cooperation in receiving and transferring technologies related to design, manufacturing, and modern information technology. Currently, Vietnam has several approaches to the circular economy, such as scrap metal recycling, paper recycling, and cleaner production models in small, medium, and micro-sized industrial production. Particularly for industrial clusters like the Nguyen Khe Industrial Cluster in Dong Anh District, it is crucial to study and apply the circular economy model in business and production activities.

2. Theoretical framework

The concept of the "circular economy" (CE) was first introduced by Pearce and Turner in 1990 as a new economic model based on the principle that "everything is an input for something else." According to statistics from the United Nations Environment Programme (UNEP), the amount of resources extracted by humans in 2017 had increased by 3.4 times compared to 50 years ago. Mathews and Tan (2016) argued that the only solution to the world's resource security issue is to transition from the linear economy model to the circular economy. Unlike the traditional linear economy, which inevitably leads to resource waste through constant extraction and disposal—especially in saturated markets—the circular economy extends the lifespan of primary resources, replacing the concept of a product's "end of life" with regeneration and restoration processes. According to Brears (2018), the CE model is developed based on four general principles: (1) Maintaining natural capital, (2) Managing product life cycles, (3) Using policy tools, and (4) Encouraging joint efforts from stakeholders. In a study by Nobre (2021), the goal of the CE is to build a zero-emission economic system with a closed-loop production cycle, from environmental extraction to industrial conversion and delivery to end consumers using clean energy sources. The material cycle in the CE operates on the philosophy of using waste as a resource, "aiming to minimize waste through the design of materials, products, engineering systems, and business models within its scope" (Ellen MacArthur Foundation, 2012).

An important aspect of this approach is that materials are accumulated within the circular economy, forming significant artificial stockpiles that can be tapped through recycling to obtain secondary raw materials, which are then reused and remanufactured to keep products within their commercial life cycle. To achieve sustainable development goals, Busu and Trica (2019) suggest that transitioning to a circular economy requires awareness of how the CE operates as well as information on the recycling system, economic objectives, and government policies to accurately determine the stages of the transition process. Additionally, studies at the micro level discuss the concept of a “circular business model.” Bocken et al. (2014) found methods to reduce environmental impact through lean production models, which help cut down energy and resource demands, thereby decreasing the need for primary resource extraction and reducing waste and pollution emissions. The closed-loop supply chain has also been recognized as one of the sustainable management models, thanks to its ability to minimize the environmental impact of businesses by applying green processes, including reducing energy, packaging, water, and non-renewable resource use; and through reverse logistics to recover and recycle products circularly (Schenkel et al., 2015).

Park et al. (2010) and Ma et al. (2014) emphasize the role of the circular economy as a policy and model to promote economic growth in a sustainable and environmentally respectful manner. The CE model has addressed the traditional zero-sum game perspective, which posits that creating economic value while promoting environmental management requires trade-offs, where leaders must choose between focusing on environmental issues or accepting economic value losses. This finding was also mentioned in a 2011 report by the United Nations Environment Programme (UNEP), which indicated that the CE model not only limits emissions and reduces dependency on natural resources but also provides significant benefits and stimulates economic growth alongside environmental protection, regenerating natural systems and aiming for sustainable development. In fact, the CE has the potential to generate global benefits worth $4.5 trillion from 2015 to 2030, according to estimates from Accenture Strategy (Lacy & Rutqvist, 2015). In OECD countries, city-level forecasts demonstrate the environmental, social, and economic impacts of the CE. Applying a CE model approach to the construction chain in the city of Amsterdam (Netherlands) would reduce greenhouse gas emissions by half a million tons of CO_2 per year (C40 Cities, 2018). Around 50,000 CE-related jobs are projected to be created in the Île-de-France region (City of Paris, 2019). However, unlocking the potential of the CE in cities and regions requires implementing necessary governance measures to create incentives (legal, financial), stimulate innovation (technical, social, institutional), and generate information (data, knowledge, capacity).

3. Methods

The study employs a combination of qualitative and quantitative research methods. The qualitative research aims to: identify the factors influencing the application of the circular economy in manufacturing enterprises within the Nguyen Khe Industrial Cluster, Dong Anh, Hanoi; define the research model; adjust the measurement scales; and refine research concepts by developing a draft measurement scale based on prior studies to create a preliminary interview questionnaire conducted via Google Forms, email, and direct surveys. The study combines interviews and surveys across 145 production stages in five types of manufacturing enterprises located in the Nguyen Khe Industrial Cluster, using convenience sampling to test the preliminary questionnaire and adjust the scales to suit the practical standards of each enterprise. Given that each type of manufacturing enterprise has stringent requirements for standardized processes, the outcome is the creation of an official questionnaire for further research. Quantitative research helps quantify the relationships between factors by applying statistical analysis tools (SPSS), and SEM, using a 5-point Likert scale to measure the value of the observed variables.

The sample size for the study was determined based on the principle that it must exceed the minimum sample size required to achieve the necessary reliability for the research. According to Tabachnick & Fidell (1991), the minimum sample size should follow the formula $n \geq 8m+50$. With 6 independent variables in the author's research model, the minimum sample size is calculated as 8*6 + 50 = 98 observations. Hair et al. (1998) suggested that the minimum sample size should be 5 observations per variable. In this study, there are 6 scales with 26 observed variables, so the minimum sample size is 26*5 = 130 observations. Therefore, the author selected a sample size of 145 to ensure reliability in data analysis. Primary data was collected through a structured questionnaire using stratified probability sampling. The survey respondents were selected from various stages of different production processes, including vertical punching machine lines for lock washers, horizontal punching machine lines for positioning rivet pins, horizontal punching machine lines for plier pins, lathe processes, spray painting, and processes on the variable pulley lathe machine, among others. The collected data was analyzed through several steps: assessing the reliability of the scales using Cronbach's Alpha coefficient, exploratory factor analysis (EFA), correlation analysis, multiple linear regression analysis, and structural equation modeling (SEM) to test the research model and hypotheses.

Based on the theories related to the application of the circular economy, there is currently no detailed research on the effectiveness of circular economy implementation in industrial enterprises within the Nguyen Khe Industrial Cluster, Dong Anh, Hanoi. The study surveyed 145 production processes and stages that affect the application of the circular economy in enterprises operating across five core business sectors: mechanics, electricity, electronics, packaging, and processing in the Nguyen Khe Industrial Cluster.

The research proposed a model consisting of six factors: maintaining natural capital, managing product life cycles, using policy tools, leadership awareness, employee awareness, and community responsibility.

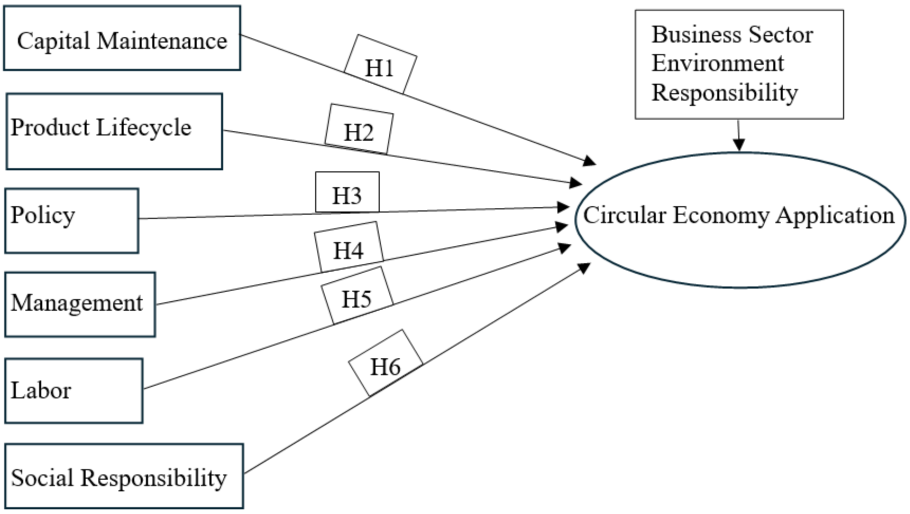

Figure 1: Research Model

Source: Author's research model

The proposed research hypotheses are as follows:

Hypothesis H1: Maintaining natural capital has an impact on the application of the circular economy (DK).

Hypothesis H2: Product life cycle management has an impact on the application of the circular economy (SP).

Hypothesis H3: Policy tools have an impact on the application of the circular economy (GD).

Hypothesis H4: Managerial awareness has an impact on the application of the circular economy (TT).

Hypothesis H5: Employee awareness has an impact on the application of the circular economy (GB).

Hypothesis H6: Community responsibility has an impact on the application of the circular economy (ST).

4. Results

4.1. Descriptive statistics of the research sample

A total of 145 survey questionnaires regarding production processes were used for analysis. The results of the survey data analysis are presented in Table 1.

Table 1: Descriptive Statistics of the Research Sample by Type of Enterprise

Type of Enterprise	Surveyed Stages and Processes	Percentage (%)
Mechanical Engineering	50	37
Wood	10	7,4
Electronics	15	11,1
Packaging	15	11,1
Processing	45	33,3
Total	**135**	**100**

Source: Author's statistical results

According to the survey, the stages and processes in the mechanical engineering sector account for 50, representing 37%; the processing sector accounts for 45, representing 33.3%; and the packaging sector accounts for 15, representing 11.1%.

4.2. Reliability assessment of measurement scales (Cronbach's Alpha)

Hair et al. (2009) suggest that a measurement scale is considered reliable and unidimensional if it has a Cronbach's Alpha value of 0.7 or higher. Nunnally (1978) also indicates that a good measurement scale should have a Cronbach's Alpha of 0.7 or above. Another important index, the Corrected Item-Total Correlation, reflects that higher values of this index indicate better observation variables, showing strong positive correlations with other variables within the scale. According to Cristobal et al. (2007), a measurement scale is deemed good if the Corrected Item-Total Correlation values of the observed variables are 0.3 or higher.

4.2.1. Exploratory factor analysis (EFA)

Based on theoretical foundations and prior research, as well as practical surveys, the study examines the application of circular economy principles in enterprises within the Nguyen Khe Industrial Cluster. The study builds on results from previous research and proposes a model consisting of six factors influencing the application of circular economy principles in enterprises within the Nguyen Khe Industrial Cluster. These factors are: maintaining natural capital, product life cycle management, use of policy tools, managerial awareness, employee awareness, and community responsibility.

Table 2: Exploratory Factor Analysis (EFA)

Rotated Component Matrix[a]						
	Component					
	1	2	3	4	5	6
SP4	.806					
SP5	.797					
SP3	.780					
SP1	.765					
SP2	.670					
DK4		.798				
DK1		.769				
DK3		.761				
DK6		.733				
DK2		.713				
TT4			.806			
TT2			.779			
TT3			.754			
TT5			.748			
TT1			.744			
TT4				.757		
GD3				.752		
GD1				.739		
GD2				.738		
GD2					.770	
ST3					.746	
ST1					.739	
ST4					.693	
GB1						.779
GB3						.753
GB2						.728

Rotation converged in 6 iterations.

Source: SPSS Data Analysis Results

4.2.2. Multiple regression analysis

The Adjusted $R^2 = 0.683$ (Table 3.3), indicating that the variables F_ST, F_GD, F_GB, F_TT, F_SP, and F_DK explain 68.3% of the variability in the dependent variable F_QD. The VIF values (<10) and the Durbin-Watson statistic ($1 < 1.723 < 3$) indicate that the model does not suffer from multicollinearity and there is no first-order correlation between adjacent errors.

Table 3: R^2 Value and Durbin-Watson Statistic

R	R^2	Adjusted R^2	Standard Error of Estimation	Durbin-Watson Statistic
.828[a]	.686	.683	.36420	1.723

a. Predictors: (Constant), F_ST, F_GD, F_GB, F_TT, F_SP, F_DK
b. Dependent Variable: F_QD

Source: SPSS Data Analysis Results

The ANOVA table shows the F-test results used to evaluate the model fit hypothesis. The F-test significance value (sig) is 0.000 < 0.05, indicating that the regression model is a good fit.

Table 4: ANOVA F-test Values

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	203.370	6	33.895	255.540	.000[b]
	Residual	93.246	703	.133		
	Total	296.616	709			

a. Dependent Variable: F_QD
b. Predictors: (Constant), F_ST, F_GD, F_GB, F_TT, F_SP, F_DK

Source: SPSS Data Analysis Results

The variable F_GB has a t-test significance value (Sig) of 0.437, which is greater than 0.05. Therefore, this variable is not significant in the regression model, meaning it does not affect the dependent variable F_QD. The remaining variables, including F_GD, F_SP, F_DK, F_TT, and F_ST, all have significance values less than 0.05, indicating that these variables are statistically significant and affect the dependent variable F_QD.

The VIF values for all independent variables are less than 10, and in this case, even less than 2, so the data do not violate the multicollinearity assumption.

Table 5: Results of Multiple Regression Analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.437	.113		-3.877	.000		
	F_GD	.091	.021	.105	4.261	.000	.734	1.362
	F_SP	.057	.021	.066	2.677	.008	.747	1.339
	F_DK	.257	.021	.311	12.062	.000	.673	1.487
	F_GB	.017	.021	.019	.778	.437	.787	1.271
	F_TT	.259	.022	.287	11.801	.000	.757	1.321
	F_ST	.388	.022	.415	17.459	.000	.793	1.260

a. Dependent Variable: F_QD

Source: SPSS Data Analysis Results

Based on the regression coefficients, we can derive the following standardized and unstandardized regression equations:

Standardized regression equation:

Y = 0.105 x F_GD + 0.66 x F_SP + 0.311 x F_DK + 0.287 x F_TT + 0.415 x F_ST + ε

Unstandardized regression equation:

Y= -0.437 + 0.388 x F_ST + 0.259 x F_TT + 0.257 x F_DK + 0.091 x F_GD + 0.057 x F_SP + ε

4.2.3. Confirmatory factor analysis (CFA)

The results of the Exploratory Factor Analysis (EFA) show the structure among the independent variables. To test the model fit, the research team continues with Confirmatory Factor Analysis (CFA). According to Hu & Bentler (1999), Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives, Structural Equation Modeling, the indexes considered to evaluate model fit include:

CMIN/df ≤ 3 is considered good; CMIN/df ≤ 5 is acceptable.
CFI ≥ 0.9 is considered good; CFI ≥ 0.95 is very good; CFI ≥ 0.8 is acceptable.
GFI ≥ 0.9 is considered good; GFI ≥ 0.95 is very good.
RMSEA ≤ 0.06 is considered good; RMSEA ≤ 0.08 is acceptable.
PCLOSE ≥ 0.05 is considered good; PCLOSE ≥ 0.01 is acceptable.

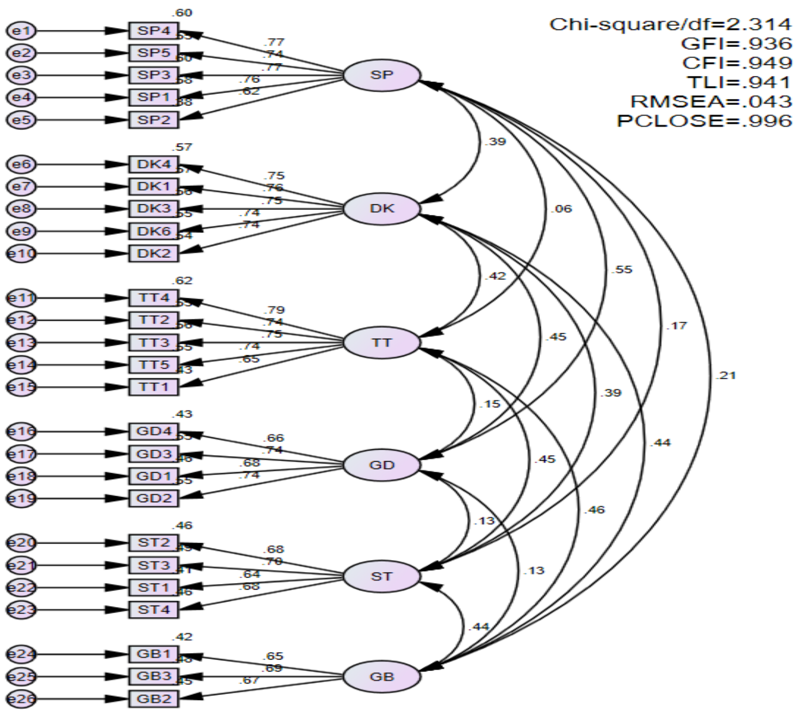

Figure 2: Confirmatory Factor Analysis (CFA) Results

Source: Data processed using Amos software

Based on the exploratory factor analysis (EFA), the author conducted a confirmatory factor analysis (CFA) to validate the theoretical model, which serves as the foundation for a set of observations. The CFA results are as follows: Chi-square/df = 2.314; GFI = .936; CFI = .949; RMSEA = .043; PCLOSE = .996. These results indicate that the factors used in the research model are suitable and achieve convergence, as shown in Figure 3.3.

The CFA results confirm that the model measuring the relationship between circular economy application and the factors of maintaining natural capital, managing product life cycle, using policy tools, managerial awareness, worker awareness, and community responsibility are consistent with the survey data. The model exhibits unidimensionality, ensures convergent validity, reliability, and discriminant validity.

4.2.4. Hypothesis testing using SEM

The SEM model was developed to test the hypotheses. The Figure 3 illustrates the proposed structural model, with the analysis results indicating a good fit for the model:

- Chi-square/df = 2.187 (less than 3)
- GFI = 0.932 (greater than 0.9)

- CFI = 0.954 (greater than 0.9)
- RMSEA = 0.041 (less than 0.05)

The results from the structural equation model are significant with a p-value less than 0.05. The paths in the model show the correlations between the variables.

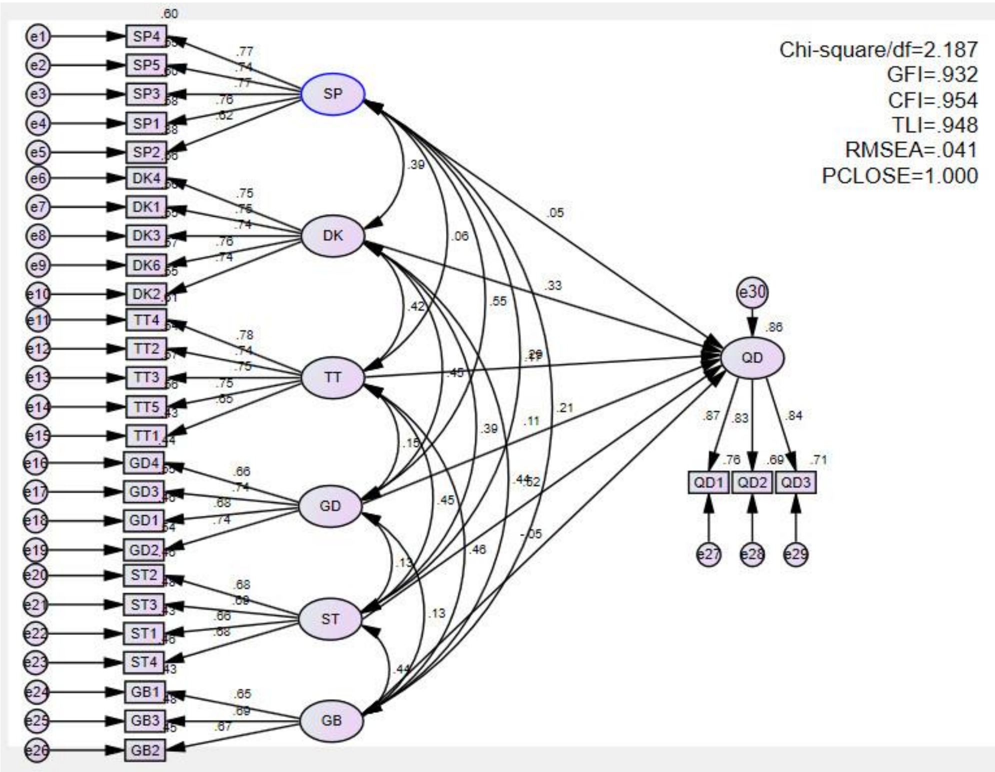

Figure 3: Structural Equation Model (SEM)

Source: Data processed using Amos software

5. Discussion

The Circular Economy (CE) requires a systemic approach to design economic development activities that benefit businesses, society, and the environment. It promotes innovation and creativity by implementing priority measures such as rejecting environmentally harmful products, applying repair, reuse, remanufacturing, recycling, and industrial symbiosis to achieve goals like reducing material and fuel consumption, extending product life cycles, and minimizing environmental waste.

According to the research findings, the factors of maintaining natural capital, managing product life cycles, using policy tools, management awareness, employee awareness, and corporate social responsibility all positively impact the application of circular economy principles in enterprises.

Post-pandemic, many businesses have adopted resource-saving measures or utilized surplus products. For example, Hung Cuong Company uses wood dust collected by vacuum machines, which is then compressed into pellets for drying furnace fuel. They also process leftover wood pieces into pellets for export to Europe and use wood dust and shavings to create biomass fuel instead of oil. The company has also implemented a circular model where biomass pellets replace fuel for boilers, and ash and sand from the boiler are used to produce non-fired bricks. Coffee waste and fruit peels are processed into organic fertilizers, steam is reused for cooling towers, and treated wastewater meets Class A standards. Similarly, TH Mechanical Joint Stock Company uses surplus shavings from production processes for sterilization and to create cleaning products for consumer use.

In the Nguyen Khe Industrial Cluster, Dong Anh, Hanoi, most businesses are private or joint ventures operating in mechanical engineering, processing, plastics, packaging, and concrete. However, post-COVID-19, the number and scale of these enterprises have contracted, leaving only key production sectors. The issue with industrial waste in the cluster is that it accumulates in the northern part, causing significant challenges for businesses, especially during rainy periods, impacting land, water, air quality, and drainage. Therefore, applying circular economy principles to recycle solid waste is a critical issue for the leaders of these businesses. Additionally, for export-oriented enterprises, applying circular economy principles can help them gain advantages in export documentation, making it a crucial factor.

Thus, businesses are adopting a systemic approach to the economy, considering various perspectives on economic and social activities. This approach shows how each reception angle affects the development potential of the circular economy in different production phases of each business.

6. Conclusion

The application of Circular Economy (CE) principles requires the involvement of all stakeholders, including central and local government authorities, raw material and mineral extraction companies, processors, manufacturers, distributors, retailers, consumers, and waste collectors. However, industrial clusters play a crucial role in creating and promoting a circular ecosystem. Enterprises within industrial clusters are key to fostering a green environment and enhancing awareness about closed-loop production processes.

CE provides essential raw materials for production processes within a framework that allows businesses and production stages to realize various closed-loop cycles. This approach helps save costs, improves environmental awareness among workers, and demonstrates corporate social responsibility. Awareness of CE among businesses is vital for improving product quality, enhancing product innovation, increasing worker income, and boosting competitive capability, ultimately ensuring smooth production and creating jobs.

Implementing CE requires a long-term commitment and effort from the entire system to gradually establish and operate production activities. It is particularly important for leadership and all staff members to be united in their commitment to social responsibility.

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Circular Economy Development in Vietnam: Opportunities, Challenges and Solutions

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Abstract

This article examines the development of circular economy in Vietnam, analyzing current progress, opportunities, challenges, and proposing solutions for future growth. Vietnam has recently introduced policies to promote circular economy, including amendments to the Law on Environmental Protection and approval of a national Circular Economy Development Scheme. Initial circular economy models have been implemented in various sectors, including eco-industrial parks, waste recycling, and sustainable agriculture. The transition presents significant opportunities such as economic benefits, environmental protection, innovation promotion, job creation, and increased foreign investment. However, challenges include limited awareness, technological constraints, financial barriers, policy gaps, inadequate infrastructure, and underdeveloped markets for recycled materials. Proposed solutions involve enhancing legal frameworks, raising awareness, promoting technological innovation, fostering collaborations, and implementing monitoring systems. The article concludes that while the path towards a circular economy in Vietnam may be challenging, it is both necessary and potentially highly rewarding, offering a future where economic prosperity and environmental sustainability coexist, ensuring a better quality of life for current and future generations.

Keywords: *Circular economy, environmental policy, sustainable development, Vietnam, waste management*

1. Introduction

In recent years, the circular economy (CE) model has gained significant attention globally as a potential solution to address the challenges of resource depletion and environmental degradation. This economic model aims to maintain the value of products, materials, and resources in the economy for as long as possible while minimizing waste generation. It stands in contrast to the traditional linear economic model of "take-make-dispose."

The circular economy concept has been embraced by many countries and international organizations as a pathway to sustainable development. According to the Ellen MacArthur Foundation, transitioning to a circular economy could generate $4.5 trillion of additional economic output by 2030 (Ellen MacArthur Foundation, 2015).

Vietnam, like many developing countries, faces the dual challenge of sustaining economic growth while protecting its environment and natural resources. Recognizing the potential of the circular economy, Vietnam has begun to take steps towards incorporating CE principles into its development strategies.

This article aims to examine the current state of circular economy development in Vietnam, analyze the opportunities and challenges presented by this transition, and propose solutions to promote the adoption of circular economy practices in the country.

2. Methods

This study employs a mixed-methods approach to examine the development of the circular economy in Vietnam, focusing on opportunities, challenges, and potential solutions. The research is guided by the following questions: What is the current state of circular economy development in Vietnam? What are the key opportunities and challenges for implementing a circular economy in Vietnam? What solutions can be proposed to promote circular economy development in Vietnam?

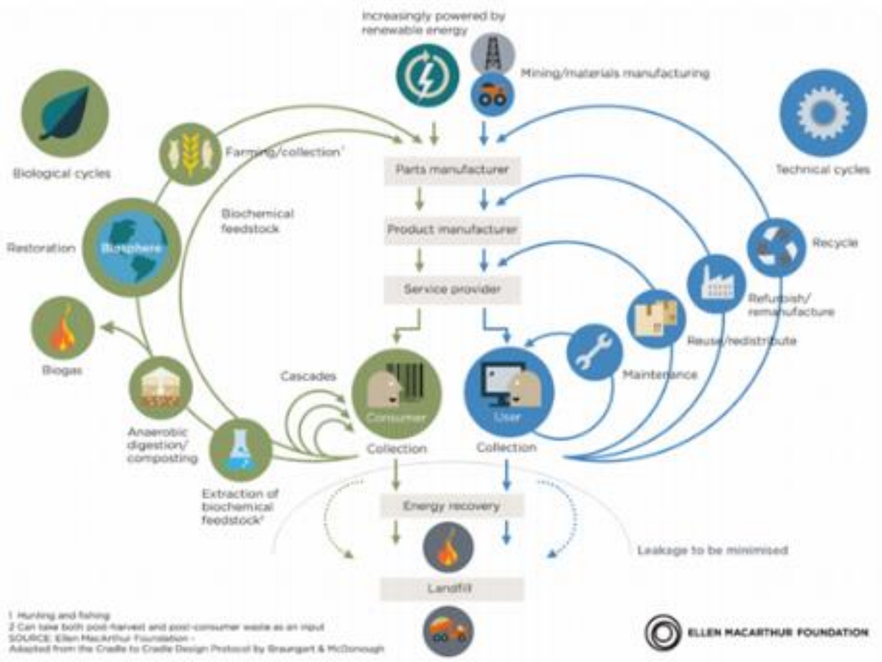

Figure 1: Ellen MacArthur Foundation's circular economy model

Source: Author's synthesis, 2024

To address these questions, the study utilizes the following methods:

Literature review: A comprehensive review of academic literature, government reports, and policy documents was conducted to understand the concept of circular economy and its application in Vietnam. This review helped establish the theoretical framework and identify key themes and issues.

Secondary data analysis: Quantitative data from various sources, including government statistics, international organizations' reports, and industry surveys, were analyzed to assess the current state of circular economy implementation in Vietnam. This analysis included metrics such as waste recycling rates, resource productivity, and renewable energy usage.

Case study analysis: Several case studies of circular economy initiatives in Vietnam were examined to provide concrete examples of implementation and identify success factors and challenges. These case studies covered various sectors, including eco-industrial parks, waste management, and sustainable agriculture.

Expert interviews: Semi-structured interviews were conducted with 15 experts from government agencies, businesses, NGOs, and academia. These interviews provided in-depth insights into the opportunities, challenges, and potential solutions for circular economy development in Vietnam.

SWOT analysis: A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was performed to synthesize the findings from the literature review, secondary data analysis, case studies, and expert interviews. This analysis helped identify key opportunities and challenges for circular economy development in Vietnam.

Comparative analysis: Vietnam's circular economy progress was compared with that of other countries, particularly in Southeast Asia, to benchmark performance and identify potential areas for improvement and learning.

Data collected through these methods were analyzed using both qualitative and quantitative techniques. Qualitative data from literature review, case studies, and expert interviews were subjected to thematic analysis to identify recurring themes and patterns. Quantitative data were analyzed using descriptive statistics and trend analysis. The triangulation of data from multiple sources and methods enhanced the validity and reliability of the findings. The combination of these research methods provided a comprehensive understanding of circular economy development in Vietnam and informed the development of proposed solutions.

The following section outlines the research methodology employed in this study, including the research questions and the methods used to address them. Subsequent sections will present the findings on the current state of circular economy development in Vietnam, analyze the opportunities and challenges, and propose solutions based on the research outcomes.

3. Results

3.1. Current state of circular economy development in Vietnam

Vietnam's transition towards a circular economy is in its nascent stages, but the country has made significant strides in recent years. The government has demonstrated its commitment through key policy initiatives, most notably the amended Law on Environmental Protection (2020), which formally introduced the concept of circular economy into Vietnam's legal framework (Government of Vietnam, 2020). Our case study analysis revealed several circular economy models being implemented across various sectors. For example, eco-industrial parks promoting industrial symbiosis have been piloted in various provinces, fostering resource efficiency and waste reduction. This was followed by the approval of the Scheme on Circular Economy Development in June 2022, setting ambitious targets such as reducing greenhouse gas emission intensity by at least 15% by 2030 compared to 2014 levels, and aiming for net-zero emissions by 2050 (Government of Vietnam, 2022). Figure 2 below illustrates Vietnam's target to reduce greenhouse gas emissions intensity from 2014 to 2050, demonstrating the country's strong commitment to transitioning to a circular and sustainable economy.

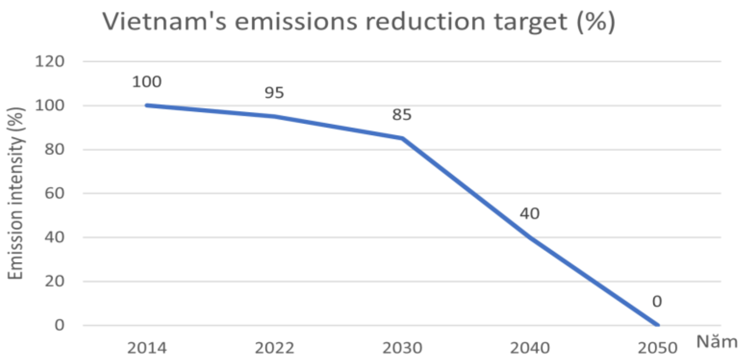

Figure 2: Vietnam's greenhouse gas emission reduction target from 2014 to 2050

Source: Author's synthesis, 2024

On the ground, several circular economy models are being implemented. Eco-industrial parks promoting industrial symbiosis have been piloted in various provinces, fostering resource efficiency and waste reduction. The establishment of the Vietnam Packaging Recycling Alliance (PRO Vietnam) in 2019 has brought together leading companies to promote the collection and recycling of packaging waste, addressing one of the country's pressing environmental issues. To better understand Vietnam's position in the international context, Table 1 compares Vietnam's waste collection rates and recycling regimes with several other countries.

Based on our secondary data analysis, we found that Vietnam's circular economy performance still lags behind global averages in several key areas. Our analysis shows that only about 85% of urban solid waste is being collected and less than 15% recycled (Asian Development Bank, 2022), highlighting significant room for improvement in waste management infrastructure (Vietnam Ministry of Natural Resources and Environment, 2023).

Table 1: Comparison of waste management and recycling

Country	Waste Collection Rate (%)	Recycling Rate (%)
Vietnam	85	15
China	95	20
Thailand	90	25
Germany	99	67
Japan	99	20

Source: Authors' survey, 2024

Corporate initiatives are also gaining traction, exemplified by Ajinomoto Vietnam's "Zero Emission" program, which has achieved a remarkable 99.97% recycling rate for its solid waste (Ajinomoto Vietnam, 2023). These efforts align with global trends, where circular economy practices have shown potential for significant economic and environmental benefits (McKinsey & Company, 2020; Ellen MacArthur Foundation, 2015). However, despite these positive developments, Vietnam still faces numerous challenges in fully implementing a circular economy. These include limited awareness among businesses and the public, technological constraints particularly for SMEs, and the need for more comprehensive policies and incentives to drive adoption across all economic sectors. The country's current waste management and recycling infrastructure also remains inadequate to support a full-scale transition to a circular economy, with only about 85% of urban solid waste being collected and less than 15% recycled (Asian Development Bank, 2022).

Through our expert interviews and SWOT analysis, we identified several key challenges, including limited awareness among businesses and the public about circular economy principles, technological constraints particularly for SMEs, the need for more comprehensive policies and incentives to drive adoption across all economic sectors, and inadequate waste management and recycling infrastructure.

These findings provide a baseline for understanding Vietnam's current position in circular economy development and inform our subsequent analysis of opportunities and challenges.

3.2. Opportunities and challenges for circular economy development in Vietnam

Our SWOT analysis, informed by expert interviews, case studies, and comparative analysis with other countries, revealed several significant opportunities and challenges for circular economy development in Vietnam.

3.2.1. Opportunities

Vietnam's transition to a circular economy presents several significant opportunities that could revolutionize its economic and environmental landscape. Economically, implementing circular economy principles could lead to substantial cost savings and new revenue streams for businesses in Vietnam. As one expert from the Ministry of Industry and Trade noted, "The circular economy could unlock new markets and increase competitiveness for Vietnamese businesses". The World Economic Forum estimates that globally, the circular economy could unlock $4.5 trillion of GDP growth by 2030 (World Economic Forum, 2014), a potential that Vietnam could tap into. Environmentally, the circular economy model offers solutions to pressing issues such as waste management and pollution. For instance, improved recycling and waste management practices could significantly reduce the 1.8 million tons of plastic waste that Vietnam generates annually (World Bank, 2022), addressing one of the country's most visible environmental challenges (United Nations Environment Programme, 2021). The shift towards a circular economy is also likely to drive innovation in product design, manufacturing processes, and business models, potentially enhancing Vietnam's competitiveness in the global market. Furthermore, the development of circular economy sectors, such as recycling and remanufacturing, presents opportunities for job creation. Drawing parallels from the European Union, where circular economy activities have already generated around 4 million jobs (European Commission, 2020), Vietnam could see significant employment growth in these emerging sectors (International Labour Organization, 2021). Lastly, as global companies increasingly prioritize sustainability in their operations and supply chains, Vietnam's commitment to circular economy principles could attract more foreign direct investment, further boosting its economic growth and technological advancement.

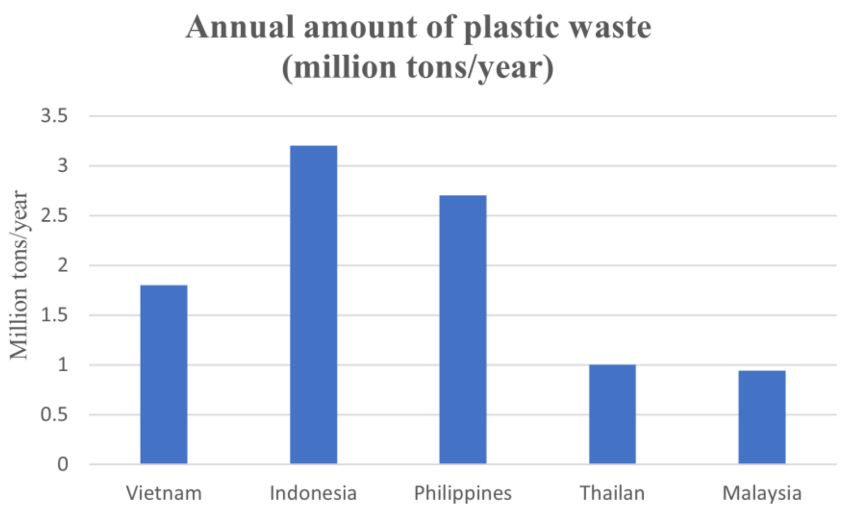

Figure 3: Chart comparing the annual amount of plastic waste between countries

Source: Authors' survey, 2024

3.2.2. Challenges

Despite the promising opportunities, Vietnam faces several significant challenges in implementing a circular economy. A primary obstacle is the limited awareness of circular economy concepts and principles among businesses and consumers, hindering widespread adoption. As one NGO representative stated, "There's a significant knowledge gap that needs to be addressed before widespread adoption can occur". This is compounded by technological constraints, particularly among small and medium-sized enterprises (SMEs), which often lack the capabilities required for circular economy implementation. Financial barriers present another hurdle, as the transition to circular practices often demands substantial upfront investments, a challenge exacerbated by the current economic climate. While Vietnam has made progress in circular economy policy development, gaps remain in crucial areas such as extended producer responsibility and green public procurement, necessitating further regulatory refinement. Infrastructure limitations pose a significant challenge, with Vietnam's current waste management and recycling systems inadequate to support a full-scale transition to a circular economy. The Asian Development Bank reports that only about 85% of urban solid waste is collected, and less than 15% is recycled (Asian Development Bank, 2022), highlighting the need for substantial improvements in waste management infrastructure. Finally, the underdeveloped market for recycled materials and remanufactured products in Vietnam creates uncertainties for businesses considering circular economy investments. These challenges collectively underscore the complexity of Vietnam's transition to a circular economy and the need for a comprehensive, multi-faceted approach to overcome them (McKinsey & Company, 2020).

Table 2: Opportunities and challenges for circular economy in Vietnam

Opportunities	Challenges
Economic benefits: Potential to unlock significant GDP growth and create new revenue streams	Limited awareness: Lack of understanding about circular economy concepts among businesses and consumers
Environmental protection: Addressing pressing issues like waste management and pollution	Technological constraints: Many businesses, especially SMEs, lack necessary technological capabilities
Innovation and competitiveness: Driving innovation in product design and manufacturing processes	Financial barriers: High upfront costs for transitioning to circular practices
Job creation: Potential for new employment opportunities in recycling and remanufacturing sectors	Policy gaps: Incomplete regulatory framework, particularly in areas like extended producer responsibility

Opportunities	Challenges
Foreign investment attraction: Increased appeal to sustainability-focused global companies	Infrastructure limitations: Inadequate waste management and recycling infrastructure
	Underdeveloped markets: Lack of established markets for recycled materials and remanufactured products

Source: Authors survey, 2024

These opportunities and challenges, identified through our comprehensive research methodology, form the basis for our proposed solutions in the following section.

4. Proposed solutions to promote circular economy development in Vietnam

Based on our research findings, including insights from expert interviews, case study analyses, and comparative studies with other countries, we propose the following additional solutions:

4.1. Enhancing legal and policy framework

To effectively promote circular economy development, Vietnam needs to strengthen its legal and policy framework. First and foremost, the country should build upon its existing environmental laws to create a dedicated circular economy legislation. This comprehensive law would provide a clear framework for implementation across all sectors, offering guidance and certainty to businesses and investors. In tandem, the government should introduce a range of economic incentives to encourage the adoption of circular economy practices. These could include tax breaks, subsidies, and other financial incentives for businesses that meet specific circular economy targets. For instance, offering reduced corporate income tax rates for companies achieving certain recycling thresholds could significantly motivate businesses to improve their waste management practices. Additionally, Vietnam should focus on strengthening and expanding its extended producer responsibility (EPR) regulations. By covering more product categories, these regulations would encourage manufacturers to design for recyclability and take responsibility for the entire lifecycle of their products, including end-of-life management. This three-pronged approach - comprehensive legislation, economic incentives, and expanded EPR - would create a robust legal and policy environment conducive to circular economy development, addressing current gaps and providing the necessary support for businesses to transition towards more sustainable practices.

4.2. Raising awareness and building capacity

Raising awareness and building capacity are crucial steps in promoting circular economy development in Vietnam. A multi-faceted approach is necessary to address this challenge. Firstly, the government should launch nationwide public education campaigns to inform citizens about circular economy principles and the importance of sustainable consumption. These campaigns could utilize various media channels, including television, social media, and community events, to reach a broad audience. Secondly, developing and implementing targeted training programs for businesses, particularly SMEs, is essential. These programs should cover circular economy concepts, strategies, and practical implementation methods, equipping businesses with the knowledge and skills needed to transition towards circular practices. The training could include case studies of successful circular economy initiatives, both domestic and international, to provide concrete examples and inspiration. Lastly, integrating circular economy principles into school and university curricula is vital for building long-term awareness and expertise. This could involve introducing sustainability and circular economy concepts in subjects ranging from science and economics to design and engineering. By educating the younger generation, Vietnam can create a workforce and consumer base that inherently understands and values circular economy principles. This comprehensive approach to awareness and capacity building would help create a societal shift towards circular thinking, fostering an environment conducive to the widespread adoption of circular economy practices across Vietnam.

4.3. Promoting technological innovation and infrastructure development

Promoting technological innovation and developing appropriate infrastructure are critical components in Vietnam's transition to a circular economy. The government should prioritize increasing funding for research and development in circular economy-related technologies, such as advanced recycling techniques and eco-friendly materials. This investment in R&D can foster innovation and help Vietnam develop locally appropriate solutions. Simultaneously, there's an urgent need to upgrade the country's recycling infrastructure. The World Bank estimates that Vietnam needs to invest about $22 billion in solid waste management infrastructure between 2020 and 2030 (World Bank, 2021). This investment should focus on developing modern waste sorting and recycling facilities to improve the efficiency of material recovery and increase the current low recycling rates. Additionally, Vietnam should expand its network of eco-industrial parks, which facilitate industrial symbiosis and efficient resource use. These parks can serve as models of circular economy principles in action, demonstrating how waste from one industry can become a valuable input for another. By combining investments in cutting-edge research, practical infrastructure development, and innovative industrial models, Vietnam can create a solid technological and infrastructural foundation for its circular economy. This approach not only addresses current waste management challenges but also positions the country to capitalize on emerging opportunities in sustainable production and consumption.

4.4. Fostering collaboration and partnerships

Fostering collaboration and partnerships is essential for accelerating Vietnam's transition to a circular economy. A multi-stakeholder approach is crucial, starting with the promotion of public-private partnerships. These collaborations can bring together the resources and expertise of government agencies, businesses, and research institutions to drive circular economy innovation and implementation. For instance, partnerships between waste management authorities and private recycling companies could improve waste collection and processing efficiency. International cooperation also plays a vital role; Vietnam should strengthen partnerships with countries and international organizations experienced in circular economy practices. This can facilitate knowledge transfer, sharing of best practices, and potential technological collaborations. Countries like the Netherlands or Japan, which have made significant strides in circular economy implementation, could provide valuable insights. Furthermore, developing sector-specific initiatives is crucial. By focusing on key sectors such as textiles, electronics, and plastics, Vietnam can create targeted circular economy programs that involve all stakeholders in the value chain. For example, a circular textiles initiative could bring together fashion brands, textile manufacturers, recycling companies, and policymakers to develop closed-loop systems for clothing production and recycling. These collaborative efforts, spanning domestic and international partnerships and sector-specific initiatives, can create a synergistic ecosystem that accelerates Vietnam's progress towards a circular economy, leveraging diverse expertise and resources for maximum impact.

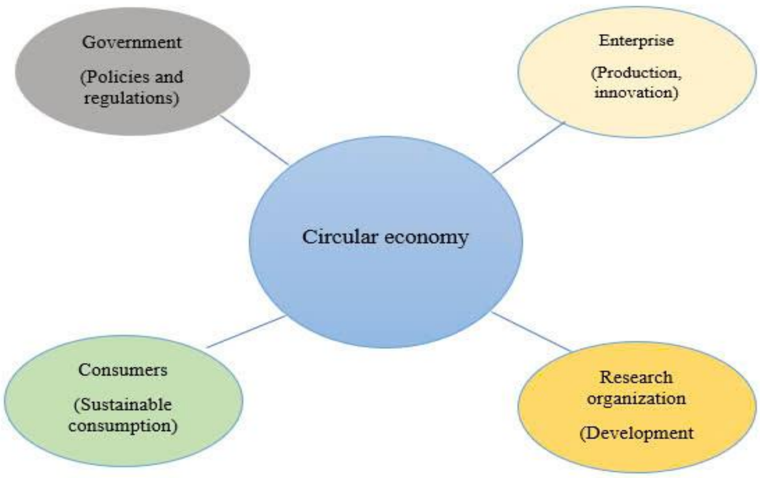

Figure 4: Diagram of relationships between stakeholders in the circular economy model
Source: Authors synthesis, 2024

4.5. Monitoring and Evaluation

Effective monitoring and evaluation are crucial for ensuring the successful implementation and continuous improvement of circular economy initiatives in Vietnam. To achieve this, the country should first establish a comprehensive set of indicators to measure progress in circular economy implementation at both national and sectoral levels.

Table 3: Table of proposed indicators to measure circular economy development progress

Indicators for Measuring Circular Economy Development Progress		
Indicator	**Description**	**Unit**
Recycling rate	Percentage of waste recycled compared to total waste generated	%
Resource productivity	GDP per unit of resource consumption	VND/kg
Renewable energy rate	Percentage of renewable energy in total energy consumption	%
CO2 emission intensity	CO2 emissions per unit of GDP	kg/VND
Green jobs	Number of jobs in circular economy-related industries	Jobs
Green R&D investment	Percentage of R&D investment in circular economy-related areas compared to total R&D investment	%

Source: Authors synthesis, 2024

These indicators could include metrics such as resource productivity, waste recycling rates, and the percentage of renewable energy use. They should align with international standards while also reflecting Vietnam's specific context and priorities. In parallel, a system of regular reporting on circular economy progress should be implemented. This could involve annual reports from key government agencies, businesses, and other stakeholders involved in circular economy initiatives. Such reports would not only ensure transparency but also facilitate the identification of successful practices and areas needing improvement. Additionally, the government could consider establishing a dedicated circular economy monitoring body to oversee data collection, analysis, and reporting. This body could also be responsible for conducting periodic reviews of circular economy policies and programs, assessing their effectiveness and recommending adjustments as needed. By implementing robust monitoring and evaluation mechanisms, Vietnam can track its progress towards circular economy goals, identify challenges early, and make data-driven decisions to refine its strategies. This approach would not only support the country's internal efforts but also demonstrate Vietnam's commitment to circular economy principles to the international community, potentially attracting further support and investment (United Nations Development Programme, 2022).

Table 4: Circular economy indicators for Vietnam

Indicator	Vietnam (2023)	Global Average	Target (2030)
Recycling rate	15%	32%	50%
Resource productivity	15,000 VND/kg	N/A	25,000 VND/kg
Renewable energy rate	10%	29%	30%
CO2 emission intensity	0.35 kg/1000 VND	N/A	0.25 kg/1000 VND
Green jobs	200,000	N/A	500,000
Green R&D investment	5%	7%	15%

Source: Authors synthesis, 2024

5. Conclusion

The transition to a circular economy presents Vietnam with both significant opportunities and challenges. As the country continues its pursuit of economic growth and development, adopting circular economy principles offers a pathway to more sustainable, efficient, and resilient economic practices. Vietnam has made commendable initial steps, particularly through policy development and pilot project implementation. However, the journey towards a fully circular economy is still in its early stages and requires concerted efforts from all sectors of society. The proposed solutions in this article - ranging from enhancing the legal and policy framework to promoting technological innovation and fostering collaboration - provide a roadmap for accelerating Vietnam's transition. Successful implementation will require strong government commitment, active business participation, and increased public awareness and engagement, as well as significant investments in infrastructure, technology, and human capital. The potential benefits are substantial, including addressing pressing environmental issues, enhancing economic competitiveness, creating new jobs, and contributing to international climate change commitments. As global attention increasingly focuses on sustainable development, Vietnam's proactive approach to circular economy development could position it as a leader among developing nations. The mixed-methods approach employed in this study, combining quantitative data analysis with qualitative insights from expert interviews and case studies, has provided a nuanced understanding of the situation. However, we acknowledge that there may be limitations to our study, such as the potential for bias in expert opinions or the rapidly changing nature of the field, which may affect the longevity of some findings. Future research could focus on sector-specific circular economy strategies, quantitative assessment of the economic impact of circular economy initiatives, or comparative studies with other developing countries implementing circular economy principles.

While the path may be challenging, it is both necessary and potentially highly rewarding, offering Vietnam a future where economic prosperity and environmental sustainability coexist, ensuring a better quality of life for current and future generations.

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Analysis of Factors Affecting Circular Economy Development in the Field of Coffee Processing Using Fuzzy Dematel

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Abstract

This study aims to analyze the relationship between factors affecting circular economy development in the coffee processing sector and identify key influencing factors. The study uses the Fuzzy DEMATEL technique to empirically study these factors based on data from three main stakeholder groups including processors, regulatory agencies and consumers. We quantify the relationships between factors using the Fuzzy DEMATEL analysis technique. The results show that policies to support the production, processing, and consumption of coffee and products made from coffee waste and cooperation between businesses in the value chain are two main factors that have a strong influence. strong and plays an important role in maintaining balance and adjusting the influence of other factors on the development of the circular economy in coffee processing. Therefore, to develop a circular economy in the coffee processing sector, there needs to be changes at the policy level including increased attention from management agencies to production, processing, and distribution activities. consumption of coffee and products processed from coffee waste.

Keywords: *Circular economy, coffee processing, Fuzzy Dematel*

1. Introduction

In the current context, the transition from a linear economy to a circular economy is an essential requirement for all countries in the world, not excluding Vietnam for the following reasons: (i) The increase in demand for raw materials, while these raw materials are increasingly depleted, especially for non-renewable mineral resources; (ii) Raw material dependence on other countries leads to political tensions globally; (iii) Impact on climate change (emission of greenhouse gases, especially CO2) making the climate increasingly extreme, causing serious consequences; (iv) Create economic opportunities, especially for business and science in the fields of innovation, design, recycling and creativity.

In Vietnam, the concept of circular economy is mentioned in Article 142, Law on Environmental Protection No. 72/2020/QH14: Circular economy is an economic model in which design, production, consumption and service activities services to reduce the exploitation of raw materials, extend product life cycles, limit waste and minimize negative impacts on the environment. Thus, implementing a circular economy is to achieve the goal of sustainable development mentioned in the concept of the World Commission on Environment and Development: "Sustainable development is development aimed at meeting the needs of the present without compromising the ability of future generations to meet their own needs" (UNEP, 1987). Both of these concepts aim at a common goal. Sustainable development provides a policy framework and long-term goals to guide and measure progress in implementing a circular economy. A circular economy provides specific strategies to achieve the goals of sustainable development. In other words, the circular economy is an important tool and approach to achieving sustainable development goals with measures such as recycling, reuse, and sustainable product design being the important means of minimizing waste and environmental impact. Circular economy and sustainable development have a close relationship and complement each other.

In Vietnam's economic activities in recent years, coffee production has played an increasingly important role. Currently, Vietnamese coffee is a famous name on the world coffee map. Vietnam's coffee area is only ranked 6th after countries: Brazil, Indonesia, Colombia, Ethiopia, and Ivory Coast. However, our country's coffee productivity is the highest in the world and it is the second largest coffee exporter in the world, second only to Brazil. As Vietnam's main export product, coffee is currently present in more than 70 countries and territories. Vietnam's coffee export turnover has increased continuously in recent years, especially from 2020 to 2023. In 2020, it reached 1.57 million tons, with a turnover of 2.74 billion USD, in 2021 it reached 1.5 million. tons with a turnover of more than 2.8 billion USD, in 2022 reaching 1.7 million tons, worth approximately 3.9 billion USD (infor, 2022). By the end of 2023, coffee exports will reach more than 1.6 million tons, down 8.7% compared to 2022, however, turnover will increase by 4.6%, reaching a record level of more than 4.24 billion USD (Ngân, 2024). This result shows that the coffee industry is one of the important industries, contributing greatly to the development of the Vietnamese economy, creating jobs, and helping millions of workers in rural areas. and the urban areas have income and improve their lives. From there, it contributes to local economic development in coffee-growing areas and creates supporting economic activities for many other industries, significantly contributing to overall economic growth.

Processing is a major activity in the coffee industry that converts raw coffee cherries into liquid coffee. This step is considered an important part of the coffee industry supply chain. Vietnamese coffee has three main processed products: green coffee for export, roasted and ground coffee (roasted coffee and powdered coffee) and instant coffee (pure instant coffee and 3-in instant coffee). 1). With about 10% of domestic coffee consumption, coffee products are mainly exported. In particular, the proportion of deeply processed coffee in Vietnam is currently very modest, accounting for only 7% of total output, the remaining is green coffee export, accounting for more than 90% (Anh, 2020). The need to increase deep processing and participate more deeply in the global coffee value chain is essential. Therefore, the coffee processing industry is considered one of our country's key development goals. Coffee processing at many different levels such as preliminary processing, roasting and brewing creates a large amount of waste including solid waste, liquid waste and gas waste. The solid waste generated from primary and secondary processing includes coffee husks, defective coffee beans, and used coffee grounds, and the waste generated by coffee shops is coffee grounds and other waste products. other types of waste (especially disposable cups). From the time the coffee beans leave the farm until the coffee pot is finished cooking, 99.8% of the biomass is discarded and only 0.2% is absorbed by the coffee drinker (Nam, Kim, & Ahn, 2017; Patrizia Ghisellini, 2016). Liquid waste, also known as wastewater, arises during the primary coffee processing stage, especially in the wet coffee processing method. Wet processing uses up to 15 m3 of water to produce one ton of clean coffee beans (Kivaisi, 2010). In addition, wastewater also arises from washing machinery and equipment and cleaning factories.

The waste gases produced from the coffee roasting process are greenhouse gases such as carbon dioxide and carbon monoxide (Kivaisi, 2010). While some modern coffee roasters now include integrated air recycling systems, older models often release these gases into the atmosphere. Most of this waste remains unused in many countries and is increasingly causing instability in waste and environmental pollution. (Adams, 2007). Many studies have shown that solid waste generated from coffee processing contains large amounts of organic substrates suitable for biological conversion into value-added products such as fertilizer; animal feed; mushroom growing substrate; renewable energy in the form of bioethanol, biodiesel, biogas; as raw materials for the production of medical and pharmaceutical products, cosmetics and food processing…, (Kivaisi, 2010) (Murthy, 2012). Using waste as production raw material helps optimize resources while reducing the cost of handling large amounts of waste during coffee processing. This is a high-quality raw material source, a green raw material source that is sustainable and long-term stable for the community and society. The economic value of coffee waste includes the totality of transactions and economic activities associated with the use and commercialization of products produced from this raw material. The coffee waste used does not decompose in landfills, thus reducing greenhouse gas emissions to help cope with climate change. This is also a way to reduce exploitation and effectively use natural resources, especially the huge amount of water being used for coffee production in the context of a serious decrease in surface water and groundwater. In addition to creating many new job opportunities, using waste as raw materials for continued production contributes to raising community awareness and promoting initiatives of great value on organic and fair trade…, thereby attracting consumers interested in sustainable products. This not only helps businesses build a sustainable brand image, creating long-term business benefits but also meets the requirements of social responsibility. The above-mentioned economic, social and environmental benefits have become the driving force behind implementing circular principles in the coffee processing sector.

In addition, the impressive growth of coffee export turnover in recent years is partly due to taking advantage of opportunities to enjoy preferential tariffs from free trade agreements (FTAs) that Vietnam signed, especially new-generation FTAs. However, Free Trade Agreements also pose non-tariff barriers, causing Vietnam's coffee exports to face many challenges. Common constraints and requirements in FTAs related to environment and origin aim to ensure that trade takes place in a fair, sustainable and responsible manner. For coffee businesses, compliance with these constraints is necessary to take full advantage of the benefits of FTAs. This is also an important reason, creating an urgent need to implement a circular economy in processing and coffee. This also contributes to improving product quality, enhancing international competition, and facilitating market expansion.

Thus, it can be seen that developing a circular economy in coffee processing is not only a need but also an opportunity to bring economic, social and environmental benefits to achieve the goal of sustainable development. sustainability of the coffee industry. This is an inevitable choice.

However, despite the above potential benefits, the development and introduction of circular principles into this field is not deep and wide due to the influence of many barriers. These barriers come from the transition to circular economy in general, circular economy in agriculture, circular economy in agricultural product processing, and circular economy in coffee processing.

These sustainability barriers are often intertwined, making it difficult to separate and address them sequentially (Jurgilevich, 2016) (Patrizia Ghisellini, 2016). Although limitations in the management and use of coffee waste have a significant impact on the environment, no studies have systematically investigated factors influencing sustainability during this period in Vietnam. Therefore, it is necessary to use a systems approach to evaluate the influence of factors. The results of this study demonstrate the influence of factors among multiple stakeholders in coffee processing, including processors, regulatory agencies and consumers. This provides a more comprehensive and systematic perspective to develop a circular economy in the management and use of this waste source. Applying such systems thinking can help uncover the interdependencies between influencing factors and provide a deeper understanding of the root causes of complex problems. The context of this research is Vietnam, a developing country with one of the world's largest coffee production activities, with a great need and commitment to implementing a circular economy. The insights generated from the study not only apply to the coffee processing sector but also shed light on similar practices in many other food production sectors that are having to transition to production and consumption sustainable use.

The study addresses the following research questions:

- What are the main factors affecting the development of a circular economy in the coffee processing sector?

- How can interdependencies between factors create a comprehensive picture of the circular economy system in coffee processing, thereby improving management and decision-making and optimising production operations?

This study answers the first question by identifying a list of important influencing factors based on literature research and an in-depth understanding of Vietnam's coffee processing sector. The study addresses the second question by using a fuzzy decision-making testing and evaluation laboratory technique (Fuzzy DEMATEL) to systematically analyze the complex interdependencies between factors.

2. Methods

By synthesizing 30 articles published between 2016 and 2021, the study (Ana Lobo, 2021) identified 24 barriers affecting the transition to a circular economy (each barrier was mentioned in at least three other articles (Figure 1).

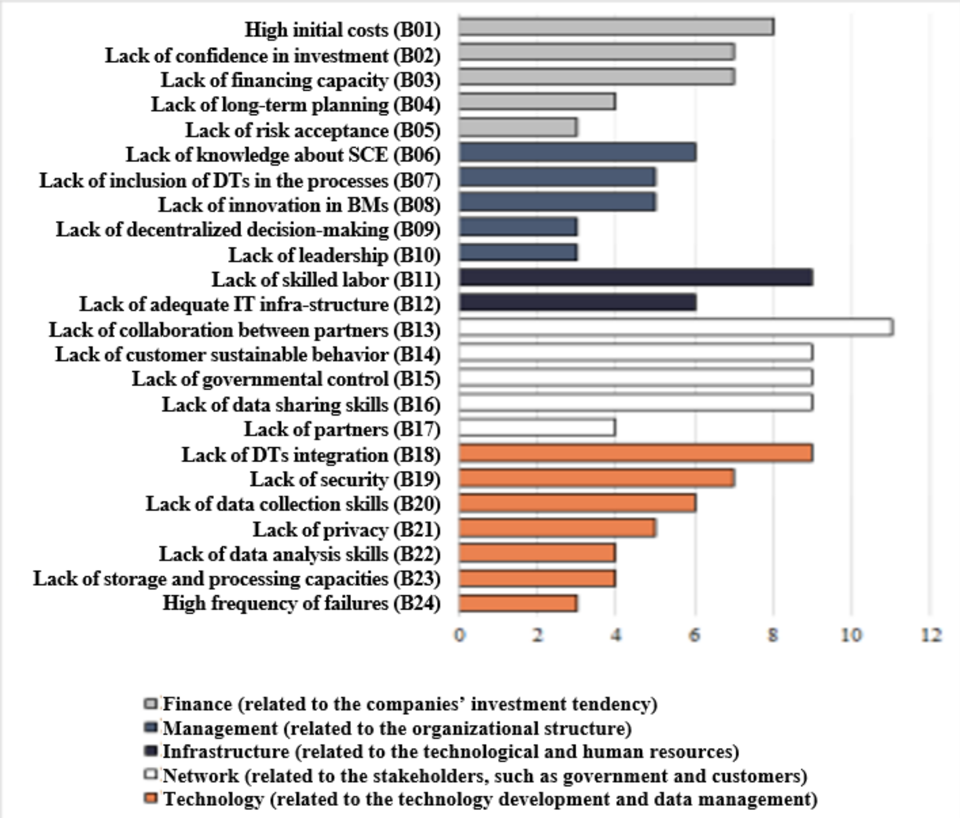

Figure 1: The number of published articles on each barrier mentioned

Source(Ana Lobo, 2021)

These 24 barriers are divided into five groups of factors: financial (related to the investment ability of the enterprise, management (related to the structure of the organization), infrastructure (related to human resources and technology), networks of relationships (related to government actors and customers) and technology (related to the level of technological development and data management).

In the study (Kuntum Melati, 2021), key barriers faced by businesses in Southeast Asia in transitioning to circular practices included: Taxes, subsidies and government support; Incentives in the supply chain; Social barriers related to consumer behaviour and perception; Infrastructure and institutional support; Technical expertise in small and medium enterprises.

The system of driving factors as well as important barriers influencing business leaders in transforming their businesses to a circular economy is a complex combination of many distinct factors, some of which push business towards circularity while others hinder it (Jovan Tan, 2022). Using a five-step method (Khalid S Khan, 2003), the authors have screened 51 published articles related to the research goal of clarifying factors that influence the transition to a circular economy. Includes: Consumer behaviour (intention - action gap); Organizational behaviour (risk attitude, aversion to change of business leaders); Policy action (refers to laws, regulations, procedures, administrative actions, incentives... by governments and other organizations, which can be both punitive and supportive); Technology, knowledge and infrastructure (including in-depth knowledge, technical know-how to move from linear to circular product life cycles such as defining circular business strategies, product design and material flow-and other relevant insights…) (Jovan Tan, 2022).

Based on the above research, we propose 6 main factors affecting the development of a circular economy in Vietnam's coffee processing sector, including:

- *Coffee processing and waste treatment technology:* For sustainable transformation, both infrastructure and technology, as well as citizens' capacities, practices and worldviews, need to change (GEELS, 2005). Recent emissions reductions have been so much slower than future requirements that a step change in technological innovation behavioural change or both is needed (Defra, 2008).

- *Consumer awareness and attitude:* Consumers play a key role in the transition to a circular economy by making more sustainable consumption choices. They need to support sustainable policies and experiments, which will help initiatives in research and production have the opportunity to develop. The speed of conversion is influenced by individual consumers, as well as larger actors (hotel industry, cafes...) and local institutions (schools, hospitals, ...). Studies have shown that people who tend to make healthier and more sustainable consumption decisions are primarily well-informed consumers. They often pay attention to product labels and are influenced by promotional campaigns (Jurgilevich, 2016).

- *Policies to support the production, processing, and consumption of coffee and products made from coffee waste.* Currently, policies addressing food waste fall within the realm of waste management. To move to a more holistic approach, the concept of sustainable production and consumption needs to be integrated across all relevant sectors, such as agriculture, food processing, retail and waste management. The circular economy provides a framework within which society can create cross-sectoral policy to support different initiatives in different parts of circularity with the ultimate goal of moving away from the linear model and shifting to a more sustainable mode of production and consumption.

- *Cooperation between businesses in the value chain:* Cooperation between businesses in the value chain plays an important role in developing a circular economy in coffee processing. Collaboration in the circular coffee value chain includes connection and coordination between parties involved in the coffee processing process (such as farmers, manufacturers, and distributors) and stakeholders to the use and processing of products from coffee waste (such as manufacturers of fertilizers, biofuels, and other biological products). More specifically, this collaboration can include: Farmers and coffee producers collaborating to optimize the coffee production process, minimize waste and maximize the use of by-products; Coffee waste product manufacturers and processors cooperate to transfer coffee waste such as coffee husks and coffee grounds to other manufacturers so they can turn them into new products such as fertilizers, construction materials, or biofuels; Distributors and end consumers collaborate to promote and consume products from coffee waste, contributing to creating a sustainable market for circular products.

-*Invest in research and development (R&D):* Investing in R&D will help improve production processes, reduce waste and optimize resource use (CIEM, 2013). R&D plays a key role in developing energy-saving technologies in coffee processing (Renewable and Sustainable Energy). Water circulation systems and energy-efficient drying technologies significantly reduce water and energy consumption, contributing to building a circular economy. R&D also helps increase the ability to reuse and recycle coffee by-products (Murthy, 2012). New methods such as biology and chemistry can convert by-products such as coffee husks into fertilizer or biofuel... reducing environmental impact and creating new economic value.

The study uses the Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) method, which is a fuzzy set extension of the standard DEMATEL technique (Fontela, 1976). This is a structural analysis method for solving complex problems by identifying and evaluating cause-and-effect relationships between factors. When combined with fuzzy logic, this method helps handle uncertain and ambiguous information. Based on the findings from the fuzzy DEMATEL analysis, the study discusses managerial and policy implications on how to address the influencing factors.

Steps to implement the Fuzzy DEMATEL method in research

Step 1: Identify factors important to research

As analyzed above, important factors related to the study include:

1. Coffee processing and waste treatment technology

2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste

3. Management and administration capacity of the enterprise

4. Consumer awareness and attitudes

5. Cooperation between businesses in the value chain

6. Invest in research and development (R&D)

Step 2: Build a fuzzy direct relationship matrix:

Step 2.1 Use fuzzy theory to collect data:

The data used to build the direct relationship matrix was collected using expert survey methods and secondary data research.

We used a fuzzy questionnaire to collect expert opinions on the direct influence of each factor on other factors. To ensure the reliability and representativeness of the data, the authors surveyed 19 experts. The selected experts are researchers, economists, experts in the field of coffee processing and circular economy, and policymakers in the fields of environmental science and economics, industrial management, and public policy.

The questionnaire was designed to include factors to evaluate and a scale to measure the level of influence. We use a scale of 5 levels: Very Weak, Weak, Moderate, Strong, and Very Strong to evaluate the influence of each factor on other factors. Questionnaires were sent via online survey method.

Table 1: Fuzzy questionnaire to collect expert opinions on the level of influence between incoming factors - Developing circular economy in the coffee processing sector

Influence of factors	Go to factor	Very weak (1)	Weak (2)	Average (3)	Strong (4)	Very strong (5)
1. Coffee processing and waste treatment technology	2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste					
	3. Management and operating capacity of the enterprise					
	4. Consumer awareness and attitudes					
	5. Cooperation between businesses in the value chain					
	6. Invest in research and development (R&D)					
2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste	1. Coffee processing and waste treatment technology					
	3. Management and operating capacity of the enterprise					
	4. Consumer awareness and attitudes					
	5. Cooperation between businesses in the value chain					
	6. Invest in research and development (R&D)					
3. Management and operating capacity of the enterprise	1. Coffee processing and waste treatment technology					
	2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste					
	4. Consumer awareness and attitudes					

	5. Cooperation between businesses in the value chain					
	6. Invest in research and development (R&D)					
4. Consumer awareness and attitudes	1. Coffee processing and waste treatment technology					
	2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste					
	3. Management and operating capacity of the enterprise					
	5. Cooperation between businesses in the value chain					
	6. Invest in research and development (R&D)					
5. Cooperation between businesses in the value chain	1. Coffee processing and waste treatment technology					
	2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste					
	3. Management and operating capacity of the enterprise					
	4. Consumer awareness and attitudes					
	6. Invest in research and development (R&D)					
6. Invest in research and development (R&D)	1. Coffee processing and waste treatment technology					
	2. Policies to support the production, processing, and consumption of coffee and products made from coffee waste					
	3. Management and operating capacity of the enterprise					
	4. Consumer awareness and attitudes					
	5. Cooperation between businesses in the value chain					

Source: Authors

Step 2.2. Build a fuzzy direct relationship matrix

Based on the data collected from the fuzzy questionnaire, we built a Fuzzy Direct Relation Matrix. This matrix represents the influence of each factor on other factors as a fuzzy number.

To build a fuzzy direct relationship matrix, expert assessments are converted into fuzzy values using sets of fuzzy numbers. Converting influence levels to fuzzy values allows modelling uncertainties and ambiguities in the analysis. We have a set of three fuzzy numbers corresponding to the following levels of influence: Very weak: (0, 0, 0.2), Weak: (0.2, 0.4, 0.6), Moderate: (0.4, 0.6, 0.8), Strong: (0.6, 0.8, 1.0) and Very Strong: (0.8, 1.0, 1.2).

Table 2: The direct relation matrix converted to fuzzy values

Factors/influences	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Factor 1	(0,0,0)	(0.2,0.4,0.6)	(0.2,0.4,0.6)	(0.6,0.8,1.0)	(0.4,0.6,0.8)	(0.6,0.8,1.0)
Factor 2	(0.6,0.8,1.0)	(0,0,0)	(0.8,1.0,1.2)	(0.4,0.6,0.8)	(0.8,1.0,1.2)	(0.8,1.0,1.2)
Factor 3	(0.8,1.0,1.2)	(0.8,1.0,1.2)	(0,0,0)	(0.8,1.0,1.2)	(0.8,1.0,1.2)	(0.8,1.0,1.2)
Factor 4	(0.4,0.6,0.8)	(0.8,1.0,1.2)	(0.8,1.0,1.2)	(0,0,0)	(0.8,1.0,1.2)	(0.6,0.8,1.0)
Factor 5	(0.8,1.0,1.2)	(0.6,0.8,1.0)	(0.8,1.0,1.2)	(0.8,1.0,1.2)	(0,0,0)	(0.8,1.0,1.2)
Factor 6	(0.6,0.8,1.0)	(0.8,1.0,1.2)	(0.8,1.0,1.2)	(0.6,0.8,1.0)	(0.8,1.0,1.2)	(0,0,0)

Source: Authors

From the above matrix, we see:

Based on the direct relationship matrix converted to fuzzy values, we can comment on the mutual influence of the factors as follows:

- Waste processing and treatment technology strongly affects factors 4 and 6 (with values (0.6, 0.8, 1.0); strongly influenced by factor 2, factor 5 and factor 6 (with values from (0.6, 0.8, 1.0) to (0.8, 1.0, 1.2).

- Policies to support the production, processing, and consumption of coffee and products made from coffee waste strongly affect all factors (with values from (0.4, 0.6, 0.8) to (0.8), 1.0, 1.2); most strongly influenced by factor 3 (with values (0.8, 1.0, 1.2).

- The management and operating capacity of an enterprise strongly affects all other factors (with values (0.8, 1.0, 1.2); most strongly affected by factor 2 and factor 4 (with values (0.8, 1.0, 1.2).

- Consumer awareness and attitude have a strong influence on all factors except factor 1 with values from (0.6, 0.8, 1.0) to (0.8, 1.0, 1.2); strongly influenced by factor 3 and factor 5 (with values (0.8, 1.0, 1.2).

- Cooperation between businesses in the value chain strongly affects all factors (with values from (0.8, 1.0, 1.2); is most strongly affected by factor 3 (with values of (0.8), 1.0, 1.2).

- The factor Investment in R&D strongly affects all factors (with values from (0.6, 0.8, 1.0) to (0.8, 1.0, 1.2); most strongly influenced by factor 2 and factor 5 (with value (0.8, 1.0, 1.2).

3. Results and Discussion

From the above analysis, we see that factors 3 and 5 have a very strong influence and are at the same time strongly influenced by other factors, showing that these may be the main influencing factors. Factor 2, factor 4 and factor 6 also have a large influence and are influenced, which shows that these are important factors. Factor 1 has a significant influence on other factors, but it is strongly influenced by other factors, showing the dependence of this factor. To determine the key factors, we need to calculate the total influence (D) and total influence (R) of each factor. Thereby, determine the importance level (D+R) and role (DR) of each factor. Continuing to use the calculation formulas, the results show that factors 3 and 5 are the key factors. Factor 3 has the highest total influence and total influence, showing that it plays an important role in influencing and being affected by other factors. A high level of importance (D+R) shows that factor 3 is the centre of the system, with great influence and receiving great attention from other factors. A positive role (DR) shows that factor 3 is mainly an influencing factor, meaning it has a great influence on other factors in the system. Factor 5 also has a high total influence and total influence, nearly equivalent to factor 3. This shows that factor 5 is also a major factor in the system. The importance level (D+R) of factor 5 is very high, showing that it is also an important factor with great influence and great attention from other factors. A positive (DR) role shows that factor 5 is mainly an influencing factor and plays an important role in influencing other factors.

4. Conclusion

Thus, Policies to support the production, processing, and consumption of coffee and products made from coffee waste and Cooperation between businesses in the value chain are two main elements in the direct relationship matrix. fuzzy contact, with the highest total influence and total affected level. Both of these factors have a strong influence and play an important role in maintaining balance and adjusting the influence of other factors on the development of a circular economy in coffee processing. Because these are key factors, optimizing these factors will have a great impact on all remaining influencing factors, thereby helping to improve the overall effectiveness of solutions to improve these factors. Factors affecting the development of circular economy in coffee processing.

This study provides a comprehensive view of the factors influencing circular economy development policies in the coffee processing sector. This fuzzy direct relationship matrix is considered an important tool to analyze the influence relationships between factors in the research and development of circular economy policies in the field of coffee processing.

Further research from this study could be to conduct field surveys to collect new data from businesses, experts and consumers in the coffee industry to help improve the accuracy of the analysis. and provide further insight into the current situation while conducting case studies to illustrate practical applications of circular economy policies in the coffee industry.

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Organic Agriculture Oriented to Circular Economy in the Northern Midlands and Mountains Region of Vietnam: Current Status and Recommendations

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Abstract

With long-term benefits for people, natural resources, and the environment, the development of organic agriculture in the direction of a circular economy has been encouraged worldwide. The Northern Midland and Mountainous Region of Vietnam has favorable conditions to develop and/or convert to organic agriculture thanks to the advantage of spacious land, diverse climate and various types of crops and livestock. However, up to now, the area of organic production is still limited. This research aims to outline the current status of organic agriculture oriented to the circular economy in the region to serve as a basis for recommending improvements or interventions. Based on secondary data collected from provinces and expert consultation, using descriptive statistical methods and case-study analysis, the study found that areas of organic farming currently are over 20 thousand hectares, accounting for nearly 1% of the total agricultural production area of the region. Organic farming has also brought higher income to farmers. The research has pointed out the main factors facilitating and hindering organic agriculture, as well as recommended several solutions to promote the development of organic agriculture oriented to a circular economy in the region in coming years.

Keywords: *Organic agriculture, circular economy, Northern midlands and mountains region*

1. Introduction

In recent years, agriculture has developed in the direction of increasing output to meet the food needs of the people. Production methods using chemical pesticides, synthetic fertilizers, etc. are wasteful of resources and increasingly pose a risk of environmental destruction. In Vietnam, each year the agricultural sector discharges about 73 million tons of solid waste and 20-30 million cubic meters of liquid waste. Of which, solid waste (plastic, fertilizer packaging, pesticides) from crop production activities is approximately 661.5 thousand tons per year, from livestock activities is about 67.93 million tons (Chu Khoi, 2023), leaving many consequences in terms of resource degradation and environmental pollution.

One of the changes that countries are making is the transition from a linear economy to a circular economy to achieve sustainable development goals and respond to climate change. At the same time, almost people believe that organic farming is better for the environment, protecting the climate and animal welfare (Seufert et al., 2017). Thus, organic agriculture has been encouraged to develop by many countries in the world. In Vietnam, the Northern Midlands and Mountains Region (NMMR) has a very special geographical location, with advantages for developing organic agriculture. However, up to now, the area of organic agricultural production is still limited, only under 1% of total agricutural production area in the region. Number of organic production enterprises and the output of organic products are still small, and the production process has not been optimally utilized in reusing waste and recovering energy. Developing organic agriculture in the direction of circular economy in the Northern Midlands and Mountains area to produce safe products at the lowest cost and limit waste generation as well as reduce negative impacts on the environment, therfore, is receiving special attention from policy makers, managers and scientists.

There are very few previous studies on organic agriculture and circular economy. Researches by FAO (1999), IFOAM (2005), Geissdoerfern et al. (2017), Vasileios Rizos et al. (2017) and some others mainly focused on providing concepts and principles for practicing organic agriculture or circular economy. Nguyen The Chinh et. al. (2024), by using Analytical Hierarchy Process (AHP) combined with GIS instruments has provided set of databases and maps of zoning areas for organic farming development in the Vietnam's Northern Midlands and Mountainous Regions.

Given the fact, this study aims to outline the current status of organic agriculture development in the circular economy direction in the Northern Midlands and Mountains region of Vietnam, its limitations and causes, and to propose some solutions to promote organic agriculture in the circular economy direction in this region in the coming years.

2. Literature review and Theoretical framework

According to the Food and Agriculture Organization of the United Nations (FAO, 1999), organic agriculture is "a comprehensive production management system that promotes and enhances the sustainability of ecosystems, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices over non-agricultural inputs, taking into account regional conditions. This is achieved through the use of agronomic, biological, and mechanical methods, in contrast to the use of synthetic inputs to perform any specific function within the system".

Organic agriculture as defined by the International Federation of Organic Agriculture Movements (IFOAM, 2005) is: "a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity, and cycles adapted to local conditions, rather than using inputs that have adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a better quality of life for all involved". According to the definition by the research group of the United States Department of Agriculture (USDA): "Organic agriculture is a system that avoids or eliminates the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives) and to the maximum extent feasible relies upon crop rotations, crop residues, animal manures, off-farm organic wastes, mineral additives, and biological systems of nutrient mobilization and plant protection".

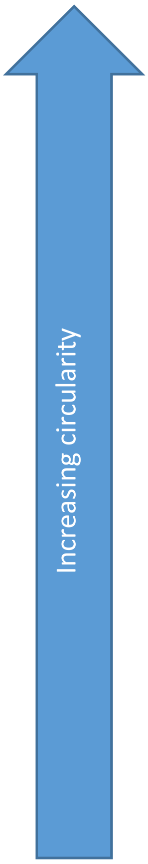
In Vietnam, organic agriculture is understood as a production system that protects soil resources, ecosystems, and human health, based on ecological cycles and biodiversity adapted to natural conditions, without using factors that have negative impacts on the ecological environment. It is a combination of traditional techniques and scientific advancements to benefit the shared environment, creating fair relationships and a balanced life for all entities within the ecosystem (GOV, 2018).

Regarding to Circular Economy (CE), according to the Ellen Macarthur Foundation (2012), CE is a system designed to be restorative and regenerative, based on three main principles: (1) Reducing and eliminating waste and pollution; (2) Extending the life of products and materials; (3) Regenerate natural systems. Thus, in a CE, the process of operation does not produce waste that harms the environment. According to Geissdoerfern et al. (2017), CE is defined as a regenerative framework in which resource inputs, waste, by-products, energy losses, and emissions are minimized by slowing, closing, and narrowing material and energy loops through better and more efficient design, maintenance, repair, reuse, regeneration, refurbishment, and recycling.

Vasileios Rizos et al. (2017) summarized various studies worldwide and outlined three fundamental principles of CE, these are: (1) Use fewer primary resources; (2) Maintain the highest value of materials and products; (3) Change the product use model.

CE operates on three principles (3R): (1) The Reduce principle: minimizing inputs of primary energy, raw materials, and waste by improving production efficiency; (2) The Re-use principle: products or components that are not waste are reused for the same purpose for which they were created; (3) The Recycle principle: waste materials are recycled into products or materials. However, the 3R framework focuses solely on 3 activities: reduce, reuse, and recycle, without addressing product design, materials selection, and production processes. Therefore, based on the basic 3R principle, some organizations and researchers have expanded from 3R to 4R and up to 10R, incorporating more activities. According to Potting et al., (2017), the 10R principle includes R0-Refuse, R1-Rethink, R2-Reduce, R3-Reuse, R4-Repair, R5-Refurbish, R6-Remanufacture, R7-Repurpose, R8-Recycle, R9-Recover. The higher the ranking of the principles, the greater the circularity achieved (Figure 1).

Circular Economy



Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering different product
	R1 Rethink	Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the market)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R3 Re-use	Re-use by another consumer of discarded product which is still in good condition and fulfils its original function
	R4 Repair	Repair and maintenance of defective products so it can be used with its original function
	R5 Refurbish	Restore an old product and bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with the same function
	R7 Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9 Recover	Incineration of materials with energy recovery

Figure 1: 10R principles of circular economy

Source: Potting et al. (2017)

The 10R principles provide the most comprehensive solutions to CE issues, addressing everything from product design to production and product processing, as well as consumer mindset. Schmidt-Rivera et al. (2020) suggested that applying EC in agriculture can be achieved through the following strategies: i) narrowing resource loops, ii) slowing resource loops, iii) closing resource loops, and iv) regenerating resource flows.

It can be seen that circular economy - oriented organic agriculture comes from two concepts: organic agriculture and circular economy. Therefore, organic agriculture oriented to circular economy can be understood as agricultural production that protects land resources, avoids or eliminates the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives), is a combination of traditional techniques and scientific advances to benefit the general environment in the direction of saving input materials of the agricultural production process and maximally treating waste of this agricultural production process.

Organic agriculture oriented towards a circular economy will focus on combining cultivation methods such as crop rotation, intensive farming, intercropping, and changing plant varieties to conserve soil, water, and other resources for production. Additionally, it involves applying scientific and technological advancements to develop new products, such as organic fertilizers, from by-products, waste, and residues from different stages of production process, to mobilize nutrients and protect plants.

3. Methods

This study used secondary data and information that were maily collected and synthesized from reports of Departments of Agicuture and Rural Development (DARD) of provinces in the NMMR. In addition, expert consultations have been conducted through some interviews to get deeper understanding on issues relating to development of organic agriculture oriented towards circular economy in the region.

Descriptive statistical methods with indicators and case-stusy analysis of Thai Nguyen's organic tea production and Bac Giang's organic cultivation models have been used to evaluate results of the development, pointed obtacles and propose suggestions to promote expansion of organic agriculture oriented towards circular economy in the region.

4. Results

4.1. Main features of the Northern midlands and mountains region

The Northern Midland and Mountainous Region (NMMR) of Vietnam consists of 14 provinces namely Cao Bang, Dien Bien, Bac Giang, Bac Kan, Ha Giang, Hoa Binh, Lang Son, Lai Chau, Lao Cai, Phu Tho, Son La, Thai Nguyen, Tuyen Quang and Yen Bai. It is one of the six important socio-economic regions of the country, have land area of 95,184.1km^2 (make up 28.73% of the country's total area) and with a population of over 13.16 million people. The region is home to approximately 30 different ethnic minority groups (GSO, 2024).

This region has rugged mountains, more suitable for agricultural than industrial development, especially in the Northeastern and Northwestern provinces. The region's major agricultural products include tea (accounting for up to 77% of the national output), pomelo (29.3% of national output), and orange (over 20% of national output). Despite having a large area of agricutural land, agricultural income only accounts for 20% of total income in the region. Lao Cai is the province with the highest agricultural income among the 14 provinces, accounting for over 33% of the average per capita income.

Industrial development is mostly concentrated in the midland provinces such as Bac Giang, Thai Nguyen, Phu Tho, etc., these are also provinces with poor air quality due to high emissions from industrial zones. The economic growth rate for the region from 2021 to 2023 was 7.65% per year, relatively high compared to the national growth rate of 5.19% (Ngoc Long, 2024).

This region has the lowest average income per capita in the country. In 2023, the average income per capita in NMMR was 3.438 million VND per person per month, the lowest among socio-economic regions and was equal to only 0.69 times the national average.

Despite significant improvements in economic scale during the last 10 years, the NMMR is still the poorest and most disadvantaged area in the country. In 2023 the poverty rate of the region was 10.7%, about 3.15 times higher than the national average of 3.4% (GSO, 2024).

4.2. Current status of organic agriculture oriented to circular economy

By the end of 2021, the organic farming area of the entire NMMR region reached 20,180.62 hectares, accounting for only 0.88% of the total agricultural production area (2,281.2 thousand hectares). Although the results achieved so far are still quite modest, they have shown the potential for organic farming development with a variety of crops in the region (Table 1).

The structure of crop groups has quite a big difference, the reason for this difference is that agricultural production has the special characteristics of relying on natural conditions and advantages of each locality (Nguyen The Chinh et al., 2024). The medicinal plant group has an area of 11,439.73 ha, accounting for the largest proportion with 56.69% of the total organic crop area in the region, of which cinnamon and star anise are mainly grown in 4 provinces of Lao Cai, Yen Bai, Lang Son and Cao Bang; ginger and turmeric are grown in Ha Quang, Cao Bang province and Pac Nam, Bac Kan province. The perennial industrial plant group ranks in the second position with an area of 8,340.56, accounting for 41.32%, of which tea trees are the main crop and grown mostly in 14 provinces.

Table 1: Area of organic farming by crops in the NMMR in 2021

No	Organic crop groups	Area (ha)	Proportion (%)
1	Fruit trees	191.20	0.95
2	Food crops	133.20	0.66
3	Medicinal Plants	11,439.73	56.69
4	Perennial industrial crops	8,340.56	41.32
5	Vegetable and spice plants	75.93	0.38
	Total area of organic farming	20,180.62	100.00
	Proportion in total agricultural production area of NMMR (%)		0.88

Source: Compiled from Reports by provincial DARD

In the case of organic tea production, Thai Nguyen is the province has the highest area, yield, production and economic value per hectare of tea in the country. Recognizing tea as a key agricultural product for many years to come, the province has encouraged expanding the scale of production while also improving quality, adding value, and enhancing the competitiveness of tea products. Tea growers are making efforts to transition from traditional to organic farming methods. Guided by agricultural extension officers they adhere to organic cultivation processes, eliminating harmful chemicals, pesticides, and inorganic fertilizers, and instead use biological pest control methods and homemade organic fertilizers. Additionally, to reduce production costs and minimize waste, the principles of a circular economy have been applied through utilizing waste from other products (such as eggs, bananas, sugar, soybeans) as raw materials for making organic fertilizer, which is then used to fertilize the tea plants, enhancing their aroma and flavor. Being asked, some heads of experienced tea households answered "*Waste from tea cultivation (branches, leaves) and by-products from tea processing (bran, tea dust) or tea residue are composted into fertilizer for tea. The production and processing stages do not waste anything*". Furthermore, advanced irrigation techniques were applized to tea fields through water-saving systems, and 70% of the tea production and processing stages were automated.

According to Thai Nguyen DARD (2022), by the end of 2022, there were 6 cooperative groups and cooperatives for organic tea production established, with a total of 186 member households and a tea area of 60 hectares certified with the Vietnamese organic standard of TCVN 11041-6:2018. Organic tea production in Thai Nguyen has higher input costs than conventional production and requires more labor, but the quality of tea produced according to organic standards is increased. Thus, the production value increases by 25% compared to tea production using traditional methods. In fact, in the models of organic tea production, the cost for 1 hectare of tea from the beginning of conversion until certification is about 360 million VND/ha, of which the support by local government is 171 million VND/ha (costs of fertilizer and pesticides alone are 105 million VND/ha), the rest is the households' counterpart (Thai Nguyen DARD, 2022).

Unlike Thai Nguyen, Bac Giang is a province with potential and strength in developing a diversified agricultural economy. In recent years, the province's agriculture has always been among the provinces with the highest agricutural growth rate in the country. Bac Giang agriculture has strong and even development in all areas of cultivation, livestock, aquaculture and forestry. The annual production scale for vegetables of all kinds is over 20 thousand hectares, fruit trees 50 thousand hectares, pigs over 1 million, chickens 15 to 17 million. Except for rice, vegetables, fruit trees, pigs and chickens are the 4 crops and animals with the largest area and output in the total agricultural production of the province.

Since Decree 109/2018/ND-CP dated August 29, 2018 of the Government on Organic Agriculture was issued, by the end of 2022, there were 6 organic production models, including 02 pig farming models of 300 pigs, 01 chicken farming model of 3,000 chicken, 01 vegetable growing model of 1 ha: 01 grapefruit growing model of 1 ha and 01 tea growing model of 1 ha. These models fully apply the production process, meet the requirements and principles according to the standards, and are certified to produce in accordance with organic agriculture standards.

Except for the organic grapefruit model, which had a bad harvest due to unfavorable weather conditions and the trees did not flower or bear fruit, the organic models all brought good results. The profits of the models increased because the selling price of the organic products on the market was 12-300%

higher than that of regular products. The value of pig and chicken farming models compared to conventional farming increased from 2-18 billion/model, the vegetable model increased by 2.4 billion/model, and the tea model increased by 3 billion/model (Table 2).

Table 2: Economic efficiency of organic agriculture models in Bac Giang province

No	Models	Output/ model (1000 kg)	Selling price of organic products (VND 1000/kg)	Selling price of regular products (VND 1000/kg)	Comparision value of organic product to regular product (%)	Profit difference between organic product and regular product (VND 1000/model
1	Pig	108	350	180	194	18,360,000
2	Chicken	100	180	160	112	2,000,000
3	Vegetables	80	60	30	200	2,400,000
4	Tea	3	1,500	500	300	3,000,000

Source: Bac Giang DARD, 2022

From the above analysis, it can be seen that the development of organic agriculture towards circular economy in recent years in the NMMR has been influenced by the following main factors:

The most important factor is the Government's policy to encourage the development of organic agriculture and the active implementation by local authorities.

Decree 109/2018/ND-CP of the Government on Organic Agriculture, together with Decision No. 885/QD-TTg of the Prime Minister approving the "Organic Agriculture Development Project for the period 2020 - 2030"; and Decision No. 5317/QD-BNN-CBTTNS dated December 28, 2020 of the Ministry of Agriculture and Rural Development (MARD) approving the “Action Plan to Implement the Organic Agriculture Development Project” have been concretized and implemented relatively widely by localities, depending on their production characteristics and resources. Acorrdingly, local governments provide different supports for diferent organic models, For example, for cinamon crop, Yen Bai government granted 100% of the cost of assessing and determining raw material areas; supported not exceeding 100 million VND/project for completing certification registration dossiers; supported 100% of the cost of assessing and granting organic certification for production areas (not exceeding 0.5 million VND/ha); supported 100% of the cost of designing samples and purchasing stamps, labels, product packaging, product certification and participating in trade promotion activities. In addition, agricultural extension agencies at all levels have organized mass communication on the benefits of organic farming and circular agriculture; organized training on organic farming techniques for farming households. Thanks to that, by the end of 2023, Yen Bai province had 8,037.76 hectares of cinnamon certified organic according to Vietnamese standards, EU standards, USDA standards (accounting for nearly 10% of the total cinnamon area in the province (Yen Bai DARD, 2023).

The second main factor is the increasing awareness of consumers and producers about organic, environmentally friendly, low-emission products.

In recent years, thanks to education and mass media activities, people's understanding of organic farming has improved. Organic products, thus, have been paid with higher prices by comsumers in the domestic markets. This helps farmers better offset production costs and can make profits from organic farming (See table 2 above).

In addition to the key factors promoting organic and circular agriculture, there are also several key factors that are hindering this development in the NMMR region.

First, organic farming requires full assurance of resource requirements for production.

Not every area has the conditions to develop organic agriculture or can be converted to organic agriculture. Organic agriculture standards require that the growing area has unpolluted soil, water, and air; and a healthy ecosystem so that natural enemies can help control pests. According to Dr. Nguyen

Quoc Vong, a senior international expert on agriculture and food safety, an area that has been farming based on chemical inputs for many years, to convert to organic agriculture may need about 10 years. Therefore, planning of organic agricultural areas needs to be carefully carried out to guide producers to choose appropriate production methods and farming conversions.

Second, organic farming requires high skilled labors and strict compliance with production, harvesting, preservation and processing processes.

Organic agriculture uses biological methods and exploiting the circulation of the ecosystem, etc. requiring producers to have in-depth knowledge and skills in these fields in order to implement principles of organic agriculture. Even once the necessary skills of organic farming are acquired, changing habits in traditional agricultural practices when converting to organic farming is not easy. Research by Vu Thi Minh (2013) noted this obtacle, especially when organic agriculture requires diligence and meticulousness in all stages of work, especially in pest and weed control, harvesting and product preservation.

Third, the cost of organic agricultural production is higher than that of conventional agriculture, especially labor costs and costs of certifying production to meet organic standards.

In the context of rural labor becoming increasingly expensive, labor-intensive organic farming practices can increase production costs, especially in provinces with high labor migration rates. In addition, according to DARDs' assessment of all provinces in the NMMR, the cost of certifying production to meet organic standards is still quite high. This partly limits the participation of farming households in the registration and certification process. As a result, by the end of 2023, the area certified organic according to Vietnamese standards is still very limited. According to MARD (2023), the area certified organic prodution according to Vietnamese standard in the NMMR in 2023 was only 271.38 hectares, accounting for 9.7% of the national total prodution area certified. Of course, the mountainous terrain, scattered production, lack of certification organizations in several provinces, along with poor transportation infrastructure also contribute to the high labor and certification costs in the region (Ha Giang DARD, 2022; Yen Bai, 2023).

Table 3: Area of fruit trees in the Northern Midlands and Mountains region certified organic according to TCVN standards in 2023 (ha)

No	Province	Fruit trees	Tea plants	Medicinal plants	Vegetables, spices plants
1	Thai Nguyen	-	75.11	2.1	-
	Bac Kan	-	-	18.57	-
3	Lang Son	1		42.4	0.8
4	Ha Giang	10	11	-	-
5	Bac Giang	1	-	-	-
6	Yen Bai	-	-	103.3	
7	Hoa Binh	-	-	-	3
8	Son La	-	-	-	2

Source: MARD, 2023

5. Discussion and Conclusion

With long-term benefits for people and the environment, the development of organic agriculture in the direction of circular economy has been encouraged worldwide. The Northern Midland and Mountainous Region of Vietnam has favorable conditions to develop and/or convert to organic, circular agriculture thanks to the advantage of spacious land, diverse climate and many types of crops and livestock. Especially in recent years, thanks to the incentive and support policies of the Government at all levels, along with the increasing awareness and willingness to pay of consumers for clean and safe agricultural products, organic and circular agricultural production in the region has achieved encouraging results. The total area of organic agriculture has reached over 20 thousand hectares, accounting for nearly 1% of the total agricultural production area of the region. Organic farming models have also brought higher income to farmers than traditional farming.

However, barriers to the expansion of and/or conversion to organic agriculture need to be resolved. These are strict conditions for organic production (quality of arable land, irrigation water, etc.); high skills and attitudes of labors; increased costs of production and standard certification, along with a number of other factors. In order to promote the development and transition to organic agriculture, based on above research resuts and expert consultation, this study proposes the following solutions:

Firstly, increase number of projects funded by local governments to build demonstration models of organic agriculture and continue to support the replication of these models.

Secondly, increase support by the government for organic production enterprises and organic farming households to improve products in terms of quality and identification of organic products to increase market access. At the same time increasing education and communication about organic agriculture oriented to circular economy so that organic agricultural products can reach more consumers.

Thirdly, complete the planning of organic production areas and plans of organic production based on applying the research results by Nguyen The Chinh et al. (2024). At the same time, it disseminates widely information on planning organic production areas so that people can proactively practice organic production or convert to organic agriculture.

Fourth, agricultural extension methods should be improved, and organic agricultural extension activities should be expanded, associated with the application of internet connection technology, to transfer knowledge and skills of organic agricultural practices more effectively to people.

Fifth, horizontal linkages and cooperation (linkages between organic agricultural producers) should be encouraged to increase production scale, save production costs and product certification costs, and vertically increase market access for organic products.

Finally, the credibility of organic agricultural production facilities and households can be improved through voluntary maintenance and compliance with the principles of organic and circular agriculture to increase prestige and gain consumer trust./.

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The Application of Circular Economy in Tourism: A case study at Koi Resort & Spa – Hoi An City

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Abstract

This study explores circular economy initiatives and practices in the tourism industry, aiming to understand the process of value creation and its contribution to sustainable development. To achieve this, a comprehensive qualitative case study was conducted at Koi Resort & Spa, located in Hoi An City, Quang Nam province, Vietnam. The research analyzes key circular economy activities that drive value creation and promote sustainable production and consumption in the tourism sector. The findings highlight that the implementation of circular economy measures primarily enhances resource efficiency, reduces emissions, and minimizes environmental impacts. This study demonstrates the importance of circular economy principles for tourism businesses, revealing the potential value opportunities for companies adopting circular models. Furthermore, practical recommendations are provided for tourism managers to implement circular economy practices, focusing on resource optimization and energy conservation, in alignment with sustainable development goals.

Keywords: *Circular economy, tourism, sustainable development, Koi Resort & Spa, resource efficiency, environmental impact*

1. Introduction

Sustainable tourism development has become a critical focus in modern economic strategies, aiming to foster future growth by ensuring efficient utilization of natural resources while addressing pressing issues such as climate change and biodiversity loss (UNWTO, 2020). In response to increasing concerns about the social and environmental sustainability of the tourism industry, the concept of the circular economy (CE) has gained significant attention in both research and practice. This approach is increasingly seen as a solution to the shortcomings of the traditional linear economy model (Berg, 2007), which has long dominated economic strategies but is now widely recognized as unsustainable.

Recent years have witnessed growing interest from researchers and practitioners in adopting circular economy principles across various sectors. Numerous studies, experiments, and managerial initiatives have explored how circular economy models can drive innovative business practices, with a particular focus on how value is generated, transferred, and captured. However, while circular economy principles have been widely discussed, their application in tourism remains underexplored, particularly from an empirical perspective. This gap in both theory and practice calls for further investigation.

The present study aims to bridge this gap by evaluating circular economy initiatives and practices within the tourism sector. Specifically, it assesses the potential value these initiatives can create and examines their impact on sustainable development. To achieve this, the research employs a qualitative case study approach, focusing on the practical implementation of circular economy strategies and their role in promoting sustainable tourism. Furthermore, this study offers practical guidance for tourism managers on the effective application of circular economy principles, highlighting opportunities for value creation through resource efficiency and waste reduction.

The circular economy emphasizes minimizing waste, optimizing resource use, and fostering regenerative systems—an approach that contrasts with the traditional linear economy model, where resources are extracted, consumed, and then discarded. In the tourism industry, the adoption of circular economy principles is particularly significant due to the sector's heavy reliance on natural resources and its considerable environmental footprint. Tourism activities, including water, energy, and food consumption, make the industry well-suited for circular strategies. By adopting circular practices, tourism businesses can not only mitigate their environmental impact but also generate long-term economic and social value. This shift is essential to ensuring the sustainability of the tourism industry, enabling businesses to meet rising consumer demand for eco-friendly practices and align with international sustainability objectives, such as the United Nations' Sustainable Development Goals (SDGs).

Additionally, the tourism industry operates within a complex value chain involving multiple stakeholders—hotels, restaurants, transportation providers, and local communities—each of which can contribute to or benefit from the adoption of circular economy practices. For example, energy-saving measures, water recycling, and waste reduction initiatives can lower operational costs for hotels while also minimizing environmental degradation. These strategies open up opportunities for service innovation, allowing businesses to offer new eco-friendly products and services that enhance the customer experience. By adopting circular economy principles, tourism businesses can position themselves as sustainability leaders, attract eco-conscious travelers, and gain a competitive advantage in the market.

2. Literature review

2.1. The effectiveness of the circular economy

In recent years, the term "circular economy" has garnered considerable attention from researchers, policymakers, and managers due to growing interest in innovative approaches to resource management. The circular economy introduces a new economic model that offers competitive advantages for businesses while also delivering significant environmental benefits. Its importance is further highlighted by the European Union's strategies and policies, such as the European Green Deal, which aims to reshape the EU into a modern, resource-efficient, and competitive economy, bolstered by recovery policies and initiatives (European Commission, 2020).

To date, scholars have invested significant efforts into conceptualizing and defining the key characteristics of the circular economy model. Various definitions have been proposed in the literature, aiming to capture the essential features of this economic approach. One of the earliest official references to the circular economy comes from Pear and Turner (1990), who described it as an economic model based on the principle that "everything is an input for something else" (Pearce, 1990). A more comprehensive definition is provided by Kirchherr et al. (2017), who define the circular economy as: An economic system based on business models that replace the concept of 'end-of-life' with reducing, reusing, recycling, and recovering materials in production, distribution, and consumption processes. This model operates on multiple levels: micro (products, companies, consumers), meso (eco-industrial parks), and macro (cities, regions, nations), with the goal of achieving sustainable development, including environmental quality, economic prosperity, and social equity, benefiting both present and future generations.

The circular economy provides numerous benefits, such as enhancing business value, driving investment and technological innovation, reducing production costs, improving supply chains, decreasing resource extraction, and minimizing waste management expenses and environmental pollution (Pearce, 1990). By fostering a closed-loop production system, it transforms waste into raw materials for future production, thereby reducing environmental impacts, protecting ecosystems, and safeguarding human health.

Scholars have also explored how circular economy practices contribute to value creation and capture processes. For instance, Urbinati et al. (2021) suggest that businesses can adopt innovative strategies to generate, capture, and distribute value within a circular economy framework. These strategies include:

- Reducing environmental impacts, such as lowering greenhouse gas emissions through energy-efficiency measures (Sassanelli et al., 2019; Su et al., 2013).

- Establishing sustainable cycles by utilizing natural, recyclable, and eco-friendly materials and promoting product circularity through design strategies like recycling, reusing, and disassembly (Sassanelli et al., 2019).

- Engaging stakeholders in the value creation process through awareness-raising initiatives, fostering shared value, and building trust through effective communication efforts (Ghisellini et al., 2016; Singh and Ordonez, 2016).

These practices require businesses to reconfigure their operations and supply chains, adopting innovative approaches to value creation, transfer, and capture. The ultimate goal is to minimize the environmental footprint of materials and products, reduce reliance on virgin resources, and ensure equitable resource distribution (EMF, 2015).

2.2. Circular economy and sustainable development

The primary goal of the circular economy is to harmonize the needs of people, the planet, and economic development (Elkington, 1997). Drawing on environmental economics principles, the circular economy employs scientific frameworks to advance sustainability goals (Mentink, 2014). Although the terms "sustainability" and "circularity" are often used interchangeably, they have distinct origins, purposes, and driving forces.

Sustainability is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). In contrast, the circular economy is based on an economic model that seeks to retain the maximum value of products, components, and materials through restorative and regenerative processes (EMF, 2015).

As Einarsson and Sorin (2020) argue, sustainability is a broader concept encompassing economic, social, and environmental benefits at a societal level, while the circular economy focuses on implementing new models of production and consumption by economic actors. Therefore, the circular economy is seen as an essential element in the transition toward sustainability (Sengers et al., 2016) and a key tool for achieving sustainable development goals. While sustainability represents the overarching goal, circularity is the mechanism by which it is achieved. As such, the circular economy enhances and supports the broader sustainability agenda, reinforcing its relevance.

Transitioning to a circular economy requires rethinking and redesigning economic growth models to focus not only on economic outcomes but also on broader social impacts (Taylor, 2021). This shift involves adopting disruptive and advanced technologies that reduce reliance on raw materials and extend the lifecycle of products (Stahel, 2013). Such a transition demands the reconfiguration of business operations and supply chains, alongside innovative strategies for value creation, transfer, and capture.

2.3. The effectiveness of the circular economy in tourism

In the post-COVID-19 context, it is essential for scholars and practitioners to guide tourism development strategies toward sustainable resource utilization by introducing innovative ideas, models, and frameworks (Del Vecchio et al., 2020; Einarsson and Sorin, 2020; Romagosa, 2020; Rodríguez et al., 2020). The circular economy has been identified as a foundational principle for establishing a sustainable and resilient tourism ecosystem (Einarsson and Sorin, 2020). Although the tourism sector significantly contributes to socio-economic progress, such as GDP, employment, and broader economic development, it also has a considerable negative environmental and social impact, including the overuse of natural resources and the degradation of ecological habitats. Tourism’s environmental footprint extends to the consumption of land, housing, transportation, fossil fuels, food, and textiles, as well as its contribution to greenhouse gas emissions (Einarsson and Sorin, 2020; Rodríguez et al., 2020).

Traditionally, the tourism industry has operated on a linear model of production and consumption, heavily relying on natural resources and raw materials (Manniche et al., 2021). However, there is increasing interest in how the tourism sector can contribute to the circular economy, given its interdisciplinary nature, complexity, and involvement in various indirect value chains (Del Vecchio et al., 2020). Recent studies have shifted focus to identifying circular economy practices in tourism by analyzing the mechanisms employed by businesses.

Studies highlight the importance of transitioning toward circular production and consumption models within tourism by engaging stakeholders in food production, transportation, construction, and other related sectors (Pamfilie et al., 2018; EMF, 2015). Practices such as recovery, reuse, redevelopment, stabilization, and regeneration (Menegaki, 2018) are central to circular tourism.

Tourism businesses and destinations can adopt circular economy strategies to reduce reliance on natural resources and mitigate environmental and social impacts (Rodríguez et al., 2020). Researchers have investigated how circular economy practices contribute to sustainable tourism by creating long-term leisure opportunities, reducing environmental impacts, and attracting eco-conscious consumers (Ma et al., 2018; Merli et al., 2019). Additionally, studies have explored customer perceptions of green practices and their influence on satisfaction and purchase intentions (Kim et al., 2017; Yusof et al., 2017), as well as the correlation between green practices and profitability (Yang et al., 2015).

Pamfilie et al. (2018) analyzed the adoption of circular economy practices in Romanian hotels, while Florido et al. (2019) outlined a roadmap for transitioning tourism destinations toward circular economy models. Manniche et al. (2021) explored how tourism and hospitality businesses integrate circular economy principles and natural capital into their operations. In the food services sector, circular practices like reuse, recycling, and waste reduction are becoming increasingly common.

At the macro level, numerous initiatives, policies, and programs have been introduced to support circular tourism. Examples include the European Ecobnb project, which connects eco-friendly accommodations, TripAdvisor's EcoLeader Award, recognizing sustainable infrastructures, and Booking's Boosting Bookings program, which provides financial support and training to businesses committed to sustainability.

Despite growing interest, research on circular tourism is still in its early stages. Further studies are required to assess how circular economy principles can be applied, identify obstacles faced by businesses during this transition, and document best practices (Rodríguez et al., 2020; Manniche et al., 2017). This study contributes to filling this gap by presenting empirical evidence of circular economy practices implemented at Koi Resort, a rural tourism destination in Hoi An City, Quang Nam Province

3. Methods

This research employs a case study approach to explore the research objectives within their natural setting, making it an ideal method when researchers have limited control over participants' actions. According to Berg (2007), the case study method enables an in-depth examination of intricate details, patterns, and components within complex systems that might be overlooked when using other research methodologies. Similarly, Creswell et al. (2007) emphasize that this approach incorporates a variety of data collection techniques, such as interviews, archival reports, documents, artifacts, and direct observation.

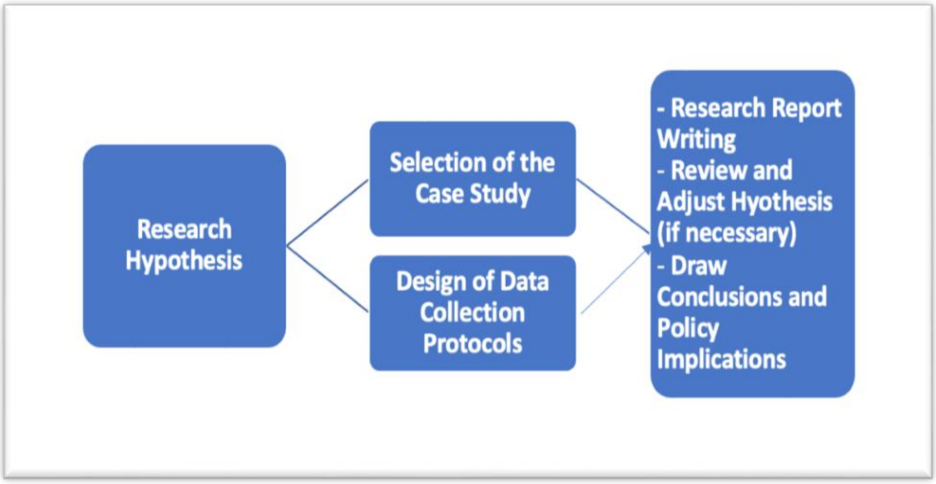

Figure 1: Research Process Diagram for the Case Study on the Implementation of the Circular Economy Model at Koi Resort & Spa, Hoi An City, Quang Nam Province

Source: COSMOS Corporation, Yin, 1994, 2003

In this study, multiple data sources were utilized to ensure data triangulation, which is crucial for developing a comprehensive understanding by integrating diverse perspectives. The data sources include:

- Semi-structured interviews with key stakeholders;
- Field notes from informal discussions;
- Internal documents and reports from the resort;
- Websites, social media, and press releases.

The research process for this case study follows a detailed framework, which is illustrated in the Figure 1.

This study aims to enhance understanding of the circular economy within the tourism sector, with a particular focus on its potential impacts. The case study of Koi Resort & Spa in Hoi An was selected due to its implementation of circular economy initiatives throughout its value chain processes. Several critical factors informed the selection of this case, including:

• The resort represents a multifunctional tourism ecosystem, aligning with the research objective of examining how hospitality establishments in the region are adopting circular economy principles to reshape the future of tourism.

• It demonstrates innovative and ambitious efforts in key areas such as material recovery, waste reduction, and energy efficiency.

• The resort's strategy is built on the principles of economic, social, and environmental sustainability.

• The resort has received numerous awards and certifications in recognition of its commitment to sustainable practices.

• The case provides a success story, offering concrete examples of the benefits of applying circular economy principles within a tourism context.

To evaluate the circular economy initiatives at Koi Resort & Spa, the study adopts the framework proposed by Urbinati et al. (2021). This framework categorizes the resort's activities into two main aspects:

- Value Network Aspect: This includes energy efficiency measures, design considerations for sustainability, the use of sustainable materials, and stakeholder engagement in value creation and resource optimization.

- Customer Value Proposition Aspect: This focuses on enhancing the resort's core offerings by leveraging various communication channels to encourage customer participation in sustainable activities, raising awareness, and building capacity among both staff and guests.

4. Results and Discussion

4.1. Case study description

This case study examines Koi Resort & Spa, located at Cua Dai Beach, Au Co Street, Hoi An City, Quang Nam Province. Recognized as a pioneer in sustainable practices, the resort has implemented a series of initiatives that emphasize environmental responsibility. The resort is part of an Eco-Resort group, reflecting its commitment to innovative and sustainable principles. These include the integration of high-tech solutions and advanced management techniques.

Koi Resort & Spa Hoi An blends traditional architecture with modern amenities, maintaining the cultural heritage of Hoi An while providing unique experiences to customers. Its design is open and nature-inspired, with rooms that feature warm yellow tones, a minimalist aesthetic, and a modern approach.

The circular economy practices at the resort are analyzed using the two-dimensional framework proposed by Urbinati et al. (2021), focusing on the Value Network Aspect and Value Proposition Aspect:

• Value Network Aspect: This includes energy efficiency initiatives, the use of long-lasting, natural, recyclable, and modular materials, stakeholder engagement in value creation initiatives across the supply chain, and communication and operational practices with stakeholders and service partners.

• Value Proposition Aspect: This covers initiatives aimed at enhancing the resort's core value proposition through its website, social media platforms, and other communication channels, along with encouraging customer participation in sustainable and circular economy activities.

Table 1: Summary of the resort's value creation initiatives

Initiative	Details
Energy-saving Solutions	- The resort has installed photovoltaic panels to generate energy from renewable sources. - Traditional light bulbs were replaced with LED technology. - Sensor devices for adaptive lighting were deployed, reducing electricity consumption. - Electricity production from the photovoltaic system is projected to increase by 15% by 2024. - CO_2 emissions have been significantly reduced.
Reuse and Recycling Initiatives	- The resort has adopted reuse and recycling methods for water and waste management. - The use of sustainable energy sources and eco-friendly products is promoted. - Advanced digital technology is integrated for environmental design.
Sustainable Resource Management	- Efficient water resource management systems are in place to reduce water consumption. - Wastewater reuse systems have been implemented. - Food waste is recycled for agricultural purposes. - Waste reduction policies aim to reduce guest-generated waste by 5% in 2021 and an additional 3% by 2023.
Stakeholder Engagement in Circular Economy Operations	- Suppliers are encouraged to adopt sustainable production and consumption practices. - The resort collaborates with the local community for sourcing goods and services. - Recruitment efforts align with local economic development and sustainability objectives. - Partnerships with sustainability organizations provide training for staff and operators.
Redesign of Value Proposition	- Sustainability initiatives and awards are showcased through the resort's website and social media platforms. - Efforts to raise customer awareness and encourage their participation in sustainable activities. - "Green" and environmentally friendly practices are prominently featured. - Sustainability certifications and awards are leveraged to strengthen the resort's circular value proposition, contributing to cost savings, positive socio-economic and environmental impacts, supply chain sustainability, and an improved reputation.

Source: Compiled by the research team from Urbinati et al., 2021

These initiatives have resulted in various benefits, including cost reductions, positive socio-economic and environmental outcomes, increased supply chain sustainability, energy efficiency improvements, development of new skills and capabilities, and enhanced brand reputation. As a result, Koi Resort & Spa has improved its competitive positioning in the tourism market by aligning with circular economy principles.

4.2. Discussion of results

Value creation through investment in energy-saving solutions

The management at Koi Resort & Spa Hoi An has demonstrated a strong commitment to implementing energy-saving strategies that aim to reduce greenhouse gas emissions and minimize environmental impacts. To achieve these objectives, the resort has invested in reducing **fossil fuel** consumption and boosting renewable energy production. Key initiatives include the installation of photovoltaic panels on sunshades in parking areas and the replacement of traditional light bulbs with LED technology. Additionally, automatic sensor devices have been deployed to enhance lighting efficiency in parking areas by 20%**,** adjusting in real-time based on natural brightness, which has significantly reduced electricity consumption and greenhouse gas emissions.

From 2015 to 2017, the use of alternative energy at the resort accounted for **3.6%** of total electricity consumption. This figure increased to 20% in 2018 and **3**5% in 2019**.** By 2021, the electricity generated by the photovoltaic system is projected to rise by **15%**, contributing to nearly **34.6%** of the resort's total energy consumption from alternative sources (Koi Resort & Spa Hoi An, 2023).

Value gained from reuse and recycling initiatives

The resort has adopted a variety of reuse and recycling initiatives, such as water and waste recycling systems, as highlighted in Table 2. Sustainable energy sources, like solar panels, are used throughout the resort, along with efforts to reduce plastic use. Fieldwork revealed a strong emphasis on **eco-**friendly products, including biodegradable catering materials and environmentally friendly cleaning agents. The resort has also implemented digital technologies that contribute to environmental sustainability, such as online check-in systems (eliminating paper use), smart room electricity management using key cards, and sensor-controlled air conditioning that only operates when doors and windows are fully closed (Field Notes and Experimental Research Evaluation).

Value creation through sustainable resource management

Tourism facilities can place significant strain on local water and energy resources, as well as biodiversity. To mitigate these impacts, the resort has implemented efficient resource management strategies, especially for water. For example, a gray water recovery system was installed to treat water from sinks and showers for non-potable uses, such as toilet flushing, fire suppression systems, fountains, irrigation, and air conditioning circuits. Additionally, the resort promotes waste reduction policies, including minimizing the use of plastic-packaged beverages and reducing unclassified and wet waste. Food waste is repurposed in agricultural production, reducing the need for chemical fertilizers. These efforts have resulted in a 5% reduction in guest-generated waste in 2021, with a further 3% reduction in 2023**.**

Value creation through comprehensive stakeholder engagement in circular economy practices

Suppliers play a crucial role in the resort's circular economy practices by supporting closed-loop systems and introducing sustainable sourcing methods. The resort works closely with the local community, sourcing goods and services locally to reduce CO2 emissions from transportation. Additionally, recruitment efforts prioritize hiring from the local community, further contributing to regional economic sustainability. The resort also collaborates with sustainability-focused organizations to provide training for staff and operators, increasing awareness of the social, economic, and environmental impacts of their activities. Employees receive training on the resort's sustainability policies and the application of circular economy principles.

Value creation through redesigning the value proposition

The resort communicates its **value proposition** through various platforms, including its website and social media, emphasizing its **sustainability initiatives** and **awards**. Special efforts are made to raise customer awareness and encourage participation in **sustainable activities**, such as the **Eco Kids program**, nature tours led by certified naturalists, and initiatives promoting respect for local flora and fauna. Additionally, the resort leverages its **sustainability certifications** to highlight the **economic, social, and environmental benefits** of its circular economy practices. These efforts contribute to **cost savings**, improved **supply chain sustainability**, an enhanced **brand reputation**, and a stronger **competitive advantage**.

5. Conclusion

The increasing awareness of resource limitations and the need for value optimization has underscored the urgent need for a transformation in the tourism industry. This transformation involves transitioning from the traditional linear tourism model to one based on the principles of the circular economy. Researchers have begun exploring how different stakeholders in the tourism value chain can adopt circular economy principles. Through a case study analysis, this research highlights the efforts of tourism enterprises to implement activities, initiatives, and opportunities to facilitate the transition to a circular economy.

However, the findings reveal that current practices primarily focus on resource efficiency**,** emission reduction**,** and environmental impact mitigation**.** Initiatives related to reuse, recycling, and material recovery are largely concentrated on waste management within hotels, such as the disposal of paper, glass, used oil, and plastics. These results align with previous studies (Manniche et al., 2021; Rodríguez et al., 2020), indicating that the shift towards a circular economy in tourism is still in its early stages, with most efforts centered on reduction and recycling.

The adoption of a circular economy business model, grounded in resilient, regenerative, and innovative strategies, could form the foundation for restarting the tourism sector post-COVID-19. Nevertheless, a full transition to a circular economy requires a multi-level, multi-dimensional approach involving technical, economic, social, cultural, and political interventions, alongside a reimagining of business objectives**.**

Theoretical contributions: This study contributes to the literature by enhancing understanding of circular economy practices in tourism**.** It emphasizes the key benefits that tourism businesses can achieve by adopting circular economy principles. By exploring the mechanisms of value creation and capture through circular economy activities, this research provides insights into how tourism companies can generate, transfer, and capture economic, social, and environmental value**.**

Practical recommendations: From a practical standpoint, this study offers actionable recommendations on how circular economy principles can be effectively implemented in the tourism sector. It provides a comprehensive analysis of viable initiatives that tourism managers can adopt to maximize value creation. Specific management strategies are necessary to successfully apply circular economy principles and contribute to the development of sustainable production and consumption models. Furthermore, this study assists managers and policymakers in understanding the frameworks required to support tourism businesses in transitioning from a linear to a circular economy model.

Limitations and future research: As with any research, this study has certain limitations. The use of a single case study limits the generalizability of the findings. Additionally, more research is needed to develop practical guidelines for designing tourism business models based on circular economy principles. Further studies could also explore the challenges and opportunities involved in transitioning to a circular economy in greater depth.

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Policy and Practices of Circular Economy and Recommendations for Vietnam

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Abstract

The “circular economy” plays a crucial role in fostering sustainable development by reducing resource consumption, minimizing waste and promoting recycling. This paper is conducted using methods including analysis, synthesis, comparison, quantitative research, and document research. Through this ways, the paper aims to analyze and evaluate Viet Nam’s orientation of implementing circular economy and current circular economy regulations and policies, it not only highlights the achievements, opportunities but also discovers and shows the big gap between policy and practice of circular economy which are leading to difficulties and challenges that arise from its legal framework and its process of applying circular economy into the road of economic and social development towards sustainable development. In addition, from the view of the comparative correlation between Viet Nam and Taiwan having the same original way of using natural resources and now both implementing circular economy, Taiwan, with its advanced policies and successful implementation of circular economy initiatives, offers valuable lessons for Viet Nam, which is still in the early stage of adopting this model. Finally, the paper concludes with recommendations and solutions for Viet Nam to apply and develop the circular economy efficiently, to enhance the circular economy efforts and overcome current difficulties and challenges, and proposes collaboration prospects between Viet Nam and Taiwan that could accelerate the adoption of circular economy practices in Viet Nam in the future.

Keywords: *Circular economy, plastic waste pollution, reducing resource consumption, sustainable development, waste recycling*

1. Introduction

Facing the context of increasingly serious environmental pollution, strongly affecting the quality of life and human development, the immediate risk of resource depletion, while the need to use natural resources for production has no tendency to decrease, a series of environmentally friendly development strategies have been born, including the circular economy model initiative.

The circular economy model is aimed at reusing materials discharged in the previous production cycle as input materials for the new production cycle, maximizing lifespan and utility of materials, contributing to minimize the need to exploit and use new natural resources. The shortcomings of the current one-way linear economy model such as waste of materials, natural resources; exhausted and not environmentally friendly exploitation; increased greenhouse gas emissions causing climate change… can be overcome by transforming economic development model to circular economy model. This model is considered an effective measure for the purpose of long-term and sustainable global development.

Europe is the birthplace of circular economy initiatives since the 1970s. Developed countries around the world were also soon aware of environmental issues, they applied circular economy model into their goals of economic development, such as Netherlands, Germany, Finland from the 2000s. Some organizations such as the Ellen MacArthur Foundation and the European Union (EU) have greatly contributed to promoting circular economy through many programs of transforming the economic model. Until 2010, circular economy officially became a central strategy in the sustainable development plans of many countries. As for the Asian region, especially the economy of Taiwan – one of the places with many achievements and experiences in applying the circular economy model in the early 2000s; Taiwan became special with an advanced waste recycling system and strict environmental policies, which helped it achieve significant progress in transforming to a circular economy model. Taiwan's achievements will become a rich source of experience for Viet Nam in the first step of the transition.

Vietnam, learning from many countries in the world and having the same awareness of the importance and urgency of sustainable and environmentally friendly development, also participates in the path of transforming the economic model in order to revive the living environment. Since 2018, the concept of "circular economy" began to be integrated into Vietnam, then became popular when used in some policies related to environmental protection and sustainable development, although not officially used, for example, the Decision of Prime Minister No. 889/QD-TTg dated 24th June, 2020 approves the National Action Program on sustainable production and consumption for the period of 2021 – 2030; the Resolution of the Government no. 136/NQ-CP dated 25th September 2020 about sustainable development. By the end of 2020, Environmental Protection Law no. 72/2020/QH14 was officially effective, making the circular economy one of 11 environmental protection policies, also a legal document with an official definition of circular economy for Viet Nam in article 142: *"Circular economy is an economic model in which activities in design, production, consumption, and service aim to reduce the exploitation of raw materials, prolong the product lifespan, limit waste generated, and minimize negative impacts on the environment",* and set goals and responsibilities for implementing circular economy for both central and local government agencies and production, business and service units. The Resolution of the 13th Congress of the Communist Party of Viet Nam 2021 also officially included circular economy as one of the criteria to guide the country's development in the period of 2021 – 2030: *"Building a green, circular and environmentally friendly economy".* Subsequently, the Decree of the Government no. 08/2022/NĐ-CP dated 10th January 2022 detailing a number of articles of the Environmental Protection Law, the Decision of the Prime Minister no. 687/QD-TTg dated 7th June 2022 approving the Circular Economy Development Project in Viet Nam was successively issued and brought the concept of circular economy deeper into Viet Nam's practice. Most recently, based on the spirit of Decision No. 687, the Ministry of Planning and Investment launched a draft decree on the circular economy development pilot mechanism, which is still in the second phase of consultation in 2023.

It can be said that Vietnam, on the path of transforming into a circular economy, is urgently perfecting the legal framework for the circular economy model to deploy synchronously and uniformly nationwide towards the goal of sustainable development by 2050. From there, the writer clearly assesses the importance and urgency of in-depth research to contribute to the development of a legal framework and policies on the circular economy, creating advanced conditions for promoting the development of this model in Vietnam, which is also the main goal of this paper. At a more macro level, this paper also contributes to analyzing prospective areas that can call for cooperation in developing a circular economy between Vietnam and Taiwan.

2. Theoretical framework and Literature review

2.1. Theoretical framework

Circular economy is developed based on many different theoretical foundations and doctrines, in which the main important theories include:

First, **t**he theory of Industrial Ecology: This is one of the fundamental foundations, proposed since the late 1980s by researchers, typically Robert Frosch and Nicholas Gallopoulos. The term "industrial ecology" was introduced by the two in their research article on "Strategies for Manufacturing", Scientific American 261, September 1989. In natural ecosystems, the concept of "waste" does not exist, the flows of matter and energy move and transform in a continuous cycle, the corpses and waste of one species will be the input for another. The energy source for the system to operate is entirely solar energy, over time this energy source is managed and stored in fossil forms. So, this theory emphasizes the similarities between industrial production processes and natural ecosystems. Industrial systems should function as ecosystems, in which the waste of one process becomes the input material for another process (Phuc, 2022).

Second, the theory of Ecological Economics: promoted by economists, notably Nicholas Georgescu-Roegen – he was the first economist to put forward a theory based on the premise that all of the earth's mineral resources will eventually be exhausted at some unspecified point in the future. This theory sees the economy operating within the ecological limits of the earth. Georgescu-Roegen argues that all natural resources are irreversibly degraded when used in economic activity, emphasizing that the economy cannot continue to grow without paying attention to the management of scarce and renewable resources (Cutler J. Cleveland & Matthias Ruth, 1996).

And third, the theory called “Cradle to Cradle” (or C2C): this term appeared in the book “Cradle to Cradle: Remaking the Way We Make Things” in 2002 by William McDonough and Braungart. C2C is also known as a regenerative design, simulating human industry after the processes of nature, in which materials are considered nutrients circulating in a healthy and safe metabolism, implying a move towards sustainability, balance and consideration for the future – the “cradle” of this generation will give birth to the “cradle” of the next generation. This theory is considered the direct basis of the circular economy, a comprehensive economic, industrial and social framework that aims to create systems that are not only efficient but also fundamentally waste-free (Rio News, 2024).

2.2. Literature review

Developing a circular economy in Viet Nam is one of the topics that attracts the attention of many experts, scholars, and researchers. A review of the domestic research on this topic is as follows:

Bui Quang Trung, Pham Huu Nam (2020), *Some solutions to promote the development of circular economy in Viet Nam*, this paper gets an overview of opportunities for circular economic development in Viet Nam and the current status of policies, awareness and resources for circular economic development, thereby proposes general solutions like improving legal framework, increasing resources and adjusting energy planning.

Le Thanh Hai (2021), *Orientation of circular economic development in the Vietnamese legal system*, this paper focuses on analyzing the concept of circular economy and Viet Nam’s approach to circular economy through the Communist Party’s policies and related regulations.

Tran Van Hieu (2022), *Circular economy – Strategy and Solutions for sustainable development of the Mekong Delta*, this paper focuses in depth on the benefits of circular economy and analyses circular economy models in the Mekong Delta region, thereby proposes some solutions to raise awareness and incentive policies for business based on the feature of Mekong Delta region.

Phan Thi Ai, Tran Nu Hong Dung (2023), *The issue of developing circular economy in Viet Nam*, the paper focuses on analyzing circular economic models in Viet Nam, then points out the current status of laws and general awareness, thereby proposes general solutions on circular economic media method, laws improvement and development of related science and technology.

Vu Thi Uyen, Nguyen Phuong Mai (2023), *Circular economic development models in the world and lessons for circular economic development in Viet Nam*, this paper focuses on analyzing some typical circular economic models of the EU and Singapore, draws out the current situation of Viet Nam related to legal policies, human resources, and then proposes some solutions as perfecting the legal corridor, developing science and technology and adjusting energy planning.

Tran Linh Huan, Le Thi Chau Giang, Pham Thi Hong Tam (2024), *Circular economic development in Viet Nam: Current situation and Recommendations for improvement*, this paper assesses the importance of circular economy and outlines the current situation of circular economic development in Viet Nam, mostly emphasizes the general situation then proposes general contributions to the guiding and regulatory role of the Government and legal system, and general awareness of Vietnamese people.

Hoang Quoc Lam, Ngo Xuan Hoa (2024), *Policies, Laws and Solutions for developing circular economy in Viet Nam*, this paper provides a summary of orientation of Viet Nam’s circular economy development project, general assessment of advantages and disadvantages of related legal policies, thereby proposes general solutions as institutionalizing legal regulations and promoting human resources.

Huynh Van Khai (2024), *Experience in developing circular economy in some countries in the world and its connection with Viet Nam*, the paper focuses on analyzing experience in developing circular economy in China, Sweden, and France, then determines the current situation of Viet Nam in terms of laws, awareness and responsibility of enterprises, thereby proposes solutions on the role of the Government and people's awareness.

Generally, existing studies point out the limitations of the law on the development of the circular economy, but do not specifically point out what the difficulties are, where they come from, while the gap between the orientation and legal regulations and practice is quite large - which will be pointed out in this paper. In addition, learning from the experiences of previous countries is also mentioned, however, Taiwan's successful circular economic models have not been mentioned and effectively exploited to become a great source of experience for Viet Nam, which will be analyzed in this paper.

3. Methods

The methods used include: analysis, synthesis, comparison, quantitative research, document research. In which, quantitative research, document research methods are used to synthesize available data from previous surveys, reports, databases to clarify the current status of recycling, waste treatment, resource use and trends of the circular economy; synthesis and analysis methods are used to synthesize theories as a basis for research on the circular economy, analyze current policies, regulations and the current status of the circular economy, thereby helping readers understand the relationship between these factors, and at the same time draw conclusions and solutions to the entire problem; comparative method is used to see the similarities and differences in the current state of the circular economy and the policies and methods applied in Viet Nam and Taiwan as well as other countries, thereby proposing appropriate recommendations to draw experience for Viet Nam.

4. Results

4.1. Viet Nam's achievements in applying circular economy

Although only in recent years has it officially begun to use the term "circular economy", a system of policies to promote minimizing waste of resources and recycling waste has been applied by Viet Nam many years ago, since the Earth Summit 1992. Proud to be the first country in the ASEAN region to start making circular economy a strategic policy in environmental protection and sustainable development, Viet Nam in recent years has got certain achievements in putting the circular economy model into practice.

The detailed implementation of the State's guidelines and policies

Viet Nam has made specific efforts through the approval of many projects and programs that directly target the issue of waste recycling, especially plastic waste, which contributes to bringing circular economy gradually into practice in production and business. In October 2018, the 8th Conference of the 12th Party Central Committee issued the Resolution no. 36-NQ/TW on the strategy for sustainable development of Viet Nam's marine economy until 2030, with a vision to 2045; the National strategy on integrated solid waste management to 2025, with a vision to 2050 was also published through the Decision of the Prime Minister no. 491/QĐ-TTg. In December 2019, the Prime Minister issued the Decision no. 1746/QĐ-TTg on the National action plan on ocean plastic waste management by 2030, set the goals that by 2030, Viet Nam will reduce 75% of marine plastic waste, collect 100% of lost or discarded fishing gear, completely eliminate the use of disposable plastic products, periodically collect and clean beaches, and periodically monitor the status of plastic waste. The cleaner production program in industry by 2020 has also been widely implemented in many small-and-medium-sized enterprises to increase the efficiency of resource use and reduce waste emissions; statistics over 12 years of implementing this strategy in industry show that up to now 68,5% of enterprises have recognized the benefits of applying cleaner production – an increase of 20,5% compared to 2010, 46% of production units have applied the cleaner production – an increase of 35,9% compared to 2010, 12% of which have achieved savings of up to 8% or more in reducing energy and raw materials per unit of product (The Communist Party of Viet Nam, 2024). In 2020, the Prime Minister continued to issue the Directive no. 33/CT-TTg on strengthening the management, reuse, recycling, treatment and reduction of plastic waste; the official action of legalizing the concept of circular economy into the Environmental Protection Law 2020 at the same time is considered a great achievement that contributes significantly to strengthening waste management and recycling, minimizing resource waste, promoting businesses and communities to switch to a more sustainable production model, typically in the way of promoting recycling and reuse of resources, especially in collecting and recycling scrap iron, paper and cleaner production in small and medium enterprises, then contributes to environmental protection and promotes the development of a green, efficient and circular economy. In 2021, the Prime Minister continued to issue successively Decision No. 175/QD-TTg in February, approving the Project of promoting propaganda on waste prevention and control for the period 2021 – 2025, and Decision No. 1316/QD-TTg in July approving the Project of strengthening plastic waste management in Viet Nam. In 2022, the promulgation of the Decree no. 08/2022/ND-CP also contributed to concretizing the waste management system according to each stage of classification, collection, transportation, recycling, and treatment, making the design and building of a circular economic system thorough from production to consumption and recycling; clarified the extended producer responsibility (EPR) for the collection and recycling of products after us, contributing to raising businesses's awareness and obligations of the development of the country's circular economy. The detailed implementation of the State's policies and guidelines on circular economy through setting specific goals is an important step in laying the foundation for the realization of the circular economy in Viet Nam.

The first step of evaluating and identifying Viet Nam's position on the path of transforming to circular economy

The Ministry of Natural Resources and Environment, in cooperation with the World Bank, has conducted research to survey the current situation of plastic waste pollution and the potential of plastic substitutes. This research contributes to providing evidence and reliable data for Viet Nam to develop policies and investment portfolios to address the problem of plastic waste. With the support and cooperation of the Pro Blue Trust Fund, a plastic pollution survey was conducted to collect data on the quantity, types and locations of plastic waste dumped into rivers and seas, also to identify the 10 most common types of plastic waste leaked into the environment. From July 2020 to January 2021, the GreenHub Center for Green Development Support collected and analyzed data in riverbank and coastal areas in 10 provinces and cities in Viet Nam (The World Bank, 2022). For the first time, Viet Nam has a representative baseline data set of beach and riverside areas on plastic waste pollution. It is an important basis for building the next comprehensive database for designing, implementing and monitoring effective intervention solutions, which helps Viet Nam determine its position on the path of transition to a circular economy model with a long-term vision towards sustainable development goals.

The realization of the circular economy model

"Garden – Pond – Barn" is one of the first models classified as economic circulation that has been applied for a long time in Viet Nam. Over time, with the gradual and official popularity of the circular economy concept, some of large enterprises in Viet Nam have caught up and built their own circular economy models, typically the pangasius farming model of Vinh Hoan Company in Cao Lanh – Dong Thap, they can control from breeding – farming – harvesting – processing – production – marketing – sales, and do not discard any part of the pangasius, including things that were previously considered waste such as skin, fat, interal organs, waste water are also turned into resources for irrigation of fruit trees, rice, dead fish and sludge into organic fertilizer, discarded packaging is used as raw material for waste treatment plants – fertilizer production; similar to the banana – cow and fish farm model of farmer Vo Quan Huy in Long An, the "rice, shrimp", "rice, fish" models in Bac Lieu, Soc Trang, Ca Mau (Hieu, 2022); or Viet Nam Dairy Products Joint Stock Company (Vinamilk) is also considered a leading enterprise in applying circular economy, manure at the cow farm is treated in Biogas pond to generate renewable energy used for milk pasteurization for calves, boiling water for daily use, drying towels, clothes, hay…, while waste is treated into fertilizer for pastures, corn, serving soil improvement, they also improve the design of pallet shrink wrap film to help reduce nearly 30,000 kg of plastic in 2022 (Viet Nam Dairy Products Joint Stock Company, 2022).

4.2. Viet Nam's difficulties and challenges in applying circular economy

Beside the initial achievements, a country that has just taken its first steps on the path of a circular economy cannot avoid difficulties and challenges in both practical situations and legal regulations.

The consumption of resources, energy

Viet Nam has become a net importer of energy, including coal and oil. It is forecasted that by 2030, Viet Nam will have to import about 100 million tons of coal per year. This not only has a negative impact on the environment but also increases production costs and reduces the competitiveness of businesses (Ai & Dung, 2023).

The alarming pollution situation

Viet Nam is among the countries with alarmingly high amounts of plastic waste. Viet Nam is facing to many risks from plastic waste, as the amount of plastic waste is increasing rapidly, from about 1,8 million tons per year in 2014, to 2,0 million tons per year in 2016 and currently about 3,27 million tons per year are discharged into the environment. The amount of plastic waste discharged into the ocean each year is up to 0,28 – 0,73 million tons per year (accounting for nearly 6% of the total amount of plastic waste discharged into the ocean of the world), but it is worth noting that only 27% of it is recycled and utilized by facilities and businesses. The treatment and recycling of plastic waste is still limited when up to 90% of plastic waste is treated by burying, filling, burning and only the remaining 10% is recycled (Hung, 2022). According to the Plastic Pollution Diagnosis Report identifying sources and pathways of plastic pollution in Viet Nam, plastic waste accounts for the majority of waste found along rivers and coastal areas. Of all types of plastic waste leaked into the environment, single-use plastic waste is the most common, plastic bags and their fragments are found the most, abandoned fishing gear is second, the 10 most common types of plastic found along rivers account for 81% of the quantity, and coastal areas account for 84% of the total amount of plastic waste leaked into water sources, of which more than 60% are single-use plastic. According to the GreenHub Center for Green Development Support, the results of a survey of riverine and coastal waste show that plastic waste leaked into the environment accounts for 94% of the total number of plastic waste pieces and 69% of the total weight of solid waste collected (The World Bank, 2022). Survey data shows that on average each household uses about 1kg of plastic bags per month, the amount of plastic waste and plastic bags in Viet Nam accounts for about 8 – 12% of solid waste, but only 11 – 12% of the amount of plastic waste and plastic bags are treated and recycled, the rest is mainly buried, burned or discharged into the environment. While according to actual records from Tuoi Tre newspaper, the use of food delivery services via apps in the community is becoming more and more popular, accompanied by a sharp increase in single-use plastic waste, accordingly, with a serving of rice, noodles, pho… at least 3 – 4 types of waste are discharged such as plastic boxes, plastic bags, plastic knives and spoons depending on the type, not including disposable industrial wooden food items such as chopsticks, knives, towels… and most of them are tough bags, hard plastic that are difficult to decompose, this number is exponential with the number of thousands of food orders every day, the rate of single-use plastic waste is indeed alarming. In addition, in the total amount of domestic solid waste that is increasing in both volume and type, the collection rate of rural domestic solid waste is still low, not classified at source, the recycling rate is low and most of it is treated by burying; on average, the national rate of collection of urban domestic solid waste is about 92%, so 8% is still not collected and is discharged into the environment, not recycled. According to the results of the General Census of Rural, Agricultural and Fishery in 2011, out of 245 craft villages that emit industrial wastewater and 546 craft villages that emit solid waste, up to 60% of craft villages do not treat wastewater and 11% do not treat solid waste (Hong, 2024). Furthermore, the classification of waste at each household before taking it to the landfill is almost never done, the situation of "conveniently" throwing waste on the streets, canals, and ditches is a common behavior without any sanctions applied, which leads to difficulties in integrating the law into the lifestyle of individuals and businesses, and challenges in how to raise people's awareness from the smallest actions that contribute to the goals of reaching circular economy and the cleanliness of the environment.

The gap between regulations, policies and practices

Firstly, although there are many policies, programs, and projects approved by the State through the ministries to specify the circular economy goals, in general, the proposed goals often encounter the problem of being unfeasible and may become "goals on paper." Specifically, according to the proposed goal of reducing 75% of plastic waste at sea in the National Action Plan on Ocean Plastic Waste

Management in 2019, there are only about 6 years left to reach the 2030 milestone, but the rate of plastic waste not collected, treated and recycled is still very high (almost 90%) and shows no signs of decreasing.

Secondly, the goal of being completely free of single-use plastics by 2030 seems to be at odds with the rapidly increasing rate of single-use plastic waste generated through food delivery apps.

Thirdly, most of the circular economy models applied in production are in large enterprises such as Vinh Hoan, Vinamilk, small-and-medium-sized manufacturing companies or spontaneous production of people seem to have no or insufficient capacity to convert – including financial and human resources reasons, moreover, the post-Covid-19 period brings heavy pressure in economic recovery for all large and small enterprises, leading to them being forced to prioritize the goal of restoring profit levels, instead of the goal of circular economy, sustainable development according to the State’s long-term strategy.

Fourthly, Viet Nam is taking its first steps on the path to a circular economy, so most of the policies that have been introduced are based on the spirit of encouragement with preferential and support mechanisms but without accompanying sanctions and without a system of standard mechanisms and specialized agencies to evaluate the application of the circular economy model in practice. For example, according to the draft Decree on applying the circular economy model testing mechanism of the Ministry of Planning and Investment, which is in the second phase of seeking comments, the Article 21 stipulates the grounds for stopping testing, including the ground at point b): *“rasing risks that are assessed by relevant competent state agencies as serious, with the potential to cause major economic, social and environmental risks, irremediable technical incidents, violation of relevant legal provisions when there are effective judgments, decisions on enforcement of judgments, and decisions on administrative sanctions”,* there are some shortcomings that the draft Decree has not resolved completely, such as: (i) there are no standards for establishing specialized teams to appraise circular economy projects applied by enteprises; (ii) there is no system of criteria to assess what constitutes a serious risk, with the potential to cause major economic, social and environmental risks; (iii) the circular economy is a new model compared to the current linear economy, so if we rely on the criteria of “violation declared in an effective judgment, decision on enforcement of judgments, and decision on administrative sanctions” to assess, it is inappropriate, not only wasting a lot of time but also creating legal loopholes that subjects can take advantage of for personal gain, not bringing about effective application of the circular economy.

Fifthly, on the path to gradually putting the circular economy into practice, setting up a mechanism for testing the circular economy model is the right step, setting up regulations on registration to be granted a testing license is also a correct step, although the application method set equally for both large and small-and-medium-sized enterprises creates a natural elimination mechanism in business, but if considering the long-term development plan and the practical socio-economic situation of Viet Nam, where more than 70% are small and medium enterprises, it is not really suitable for setting up a common standard in registration. This regulation has invisibly closed the gate towards the circular economy for small and medium enterprises because they do not have enough capacity to register for testing and transformation.

People’s awareness

Circular economy is a new concept for people, it poses responsibility not only for the State, Government, businesses but also for people, from the smallest actions of people also contribute to promoting the quick integration of the circular economy model, for instance, awareness of waste classification at home, not littering, limiting or not using plastic bags, disposable products. These are all the most basic tasks, but in reality, they have not been implemented in daily life without any sanctions applied, although the sanctions are fully regulated. For businesses, business owners, putting benefits first without the awareness of respecting and complying with the laws has led to many violations in illegal waste discharge, causing environmental pollution and not converting the economic model because they do not want to spend the cost of conversion. According to the General Statistics Office’s report, the number of environmental violations handled in the period of 2012 – 2021 increased more than 5,7 times, from 2.438 cases in 2012 to 14.042 cases in 2021 (Hong, 2024).

5. Discussion and Conclusion

5.1. Discussion

Facing the difficulties and challenges on the path of applying circular economy, along with the goal of promoting and making circular economy a strategic policy, transforming Viet Nam's economy into a circular one in the future, shortening the gap between legal regulations, policies and practices is an urgent action, thereby also enhancing the awareness of the entire population about the importance of circular economy. To do this, we must first base on the current socio-economic situation of Viet Nam, then learn from places with successful circular economy models, such as Taiwan – a place with a situation of using and importing up to 90% energy similar to Viet Nam, which has had certain successful steps in reducing imports and resource use, while developing circular economy.

Taiwan, which has over 20 years of experience in applying the circular economy model, with the "5+2" Strategy – with 5 industries (Asian Silicon Valley, Biomedical industry, Green energy technology, Smart machine, and National defense industry) and 2 strategies (circular economy and new agriculture), and Circular Economy Promotion Plan with 4 strategies (promote the research and development of circular technologies and material innovation and establish a special zone for this purpose, build demonstration circular parks, promote green consumption and transaction, facilitate energy and resource integration as well as industrial symbiosis) and 2 axes (circular industrialization and industrial circulation) (Circular Taiwan Network, 2024) have helped Taiwan achieve many achievements, attracted the attention of many industries to the circular economy model and gradually breaking away from the linear one, which contributes to accelerating the upgrading of 5 industries to become innovative in the short term and the transformation and redesign of all industries in the long term, then creates a circular and sustainable model, and solves the dilemma between pursuing industrial development and sustainable development starting from materials.

For Viet Nam, the importance thing in the first foundational steps is a clear orientation, the goal is not too far from reality but instead should be specific actions. I propose some recommendations based on current difficulties as follows:

The first, the State, with its leading role in development orientation, should set out the goals of circular economy projects and programs in a more realistic manner, limiting or completely eliminating "paper numbers". To achieve this, specialized agencies should continuously conduct surveys monthly, quarterly and annually in each region and locality to accurately grasp the fluctuations of waste, plastic pollution and waste recycling. Then, there will be a basis for exactly assessing Viet Nam's position on the circular economy path, in order to propose more appropriate policies and goals.

Second, planning and development of legal regulations and assessment standards on circular economy should be separated for large enterprises and small-and-medium-sized enterprises to ensure that everyone has the opportunity to approach and convert to a circular economy model based on their available capacity, including all stages of registration – licensing – testing – experimentation – maintenance – upgrading.

Third, learning from Taiwan's experience, the development of eco-industrial parks, building demonstration circular parks (The Ministry of Economic Affairs, 2019), and introducing and applying the action of industrial symbiosis are some of effective measures and lessons suitable for Viet Nam. This is where recycling technologies and efficient use of resouces are concentrated, which helps to reduce waste and create a sustainable supply chain. This closed-loop platform from the experience of large enterprises in Viet Nam (Vinamilk, Vinh Hoan, etc.) should be expanded to the scope of "chains", "regions" in the spirit that waste from the production process of this enterprise becomes a source of input materials for the production process of other enterprises in the supply chain. Industrial symbiosis activities can be implemented based on a platform system of integrated registration information, allowing enterprises to register waste – input materials, thereby matching their supply and demand of products with other similarly registered enterprise's.

Fourth, Viet Nam needs to establish a waste management system, with strong investment in recycling technology and a waste separation system at the source – which is currently a techonological weakness in Viet Nam. This way can be learnt from Taiwan's experiences and technologies.

Fifth, Viet Nam should set up and develop a Resource Management Strategy based on the product life cycle model, similar to the EU's approach, to maximize resource efficiency and minimize environmental impacts in the four stages of the product life cycle: production – consumption – waste management – market for secondary raw materials, in which the extended producer responsibility (EPR) must be thoroughly applied.

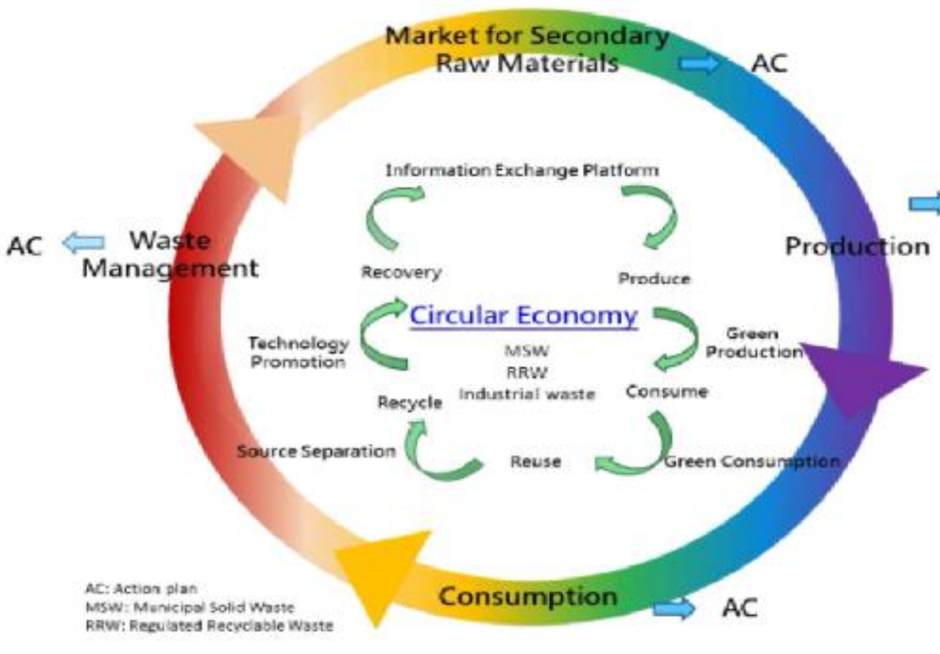

Figure 1: Schematic diagram of resource management strategy

Source: Environmental Protection Agency (EPA)

Sixth, the work of promoting the circular economy to every smallest actions of people, consumers need to be urgently focused on improving, because this is the root of the problem, incentives must go hand in hand with punitive policy to be able to improve people's awareness in the long term. The work that needs a specific program includes: rectifying and promoting green consumption, expanding incentives for circular shopping and green recovery, maximum support for waste classification at home, high taxes on disposable plastic products, strict penalties for littering on the streets, rivers, streams, ponds, and lakes – this is one of the actions that has been left unanswered for a long time until now.

In addition, areas with high potential for cooperation between Viet Nam and Taiwan include: (1) recycling and waste management industry: sharing of technology systems and cycles; (2) green technology and cleaner production: especially textiles and plastics production, wind power and solar power, which helps Viet Nam access advanced technologies; (3) smart cities and sustainable infrastructure: this is a new field that is essential for future development that both Viet Nam and Taiwan are aiming for; (4) sustainable agriculture: reusing agricultural by-products, developing organic industry and biotechnology; (5) education and awareness raising: exchanging students, experts, organizing seminars and training programs to enhance knowledge and skills on circular economy for the workforce and the community; (6) technology transfer and investment, and (7) information technology and data management.

5.2. Conclusion

In summary, the circular economy in Viet Nam has become an important strategy towards the goal of sustainable development, environmental protection and improving the efficiency of resource use. Through legal documents, guidelines and policies, Viet Nam has taken the first solid steps in integrating the circular economy into the legal framework. However, to realize this model and make it professional, Viet Nam needs to continue to focus resources on investment to improve and enhance public awareness, develop human resources, especially promote international cooperation to learn, apply successful lessons and attract foreign investment in terms of capital, human resources and technology. The complete transition to a circular economy model will not only help Viet Nam solve environmental challenges but also create momentum for sustainable economic development in the future.

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Development of Advanced Materials for Industrial Wastewater Treatment, Utilization of Agricultural By-product Toward Circular Bioeconomy

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Abstract

Global population growth, rising energy demand, and environmental concerns related to fossil fuels have driven a shift toward renewable energy and biofuels. Vietnam faces the challenge of managing large amounts of agricultural by-products, which hold potential as sustainable resources, notably coconut husks and durian peels. Both are rich in lignocellulosic materials like cellulose, hemicellulose, and lignin, making them ideal for recycling into useful products. To maximize resource utilization, reduce waste, and create new high-value goods from these by-products, the circular bioeconomy solution is presented as a promising and effective solution. This study focuses on extracting lignin from both coconut husks and durian peels, followed by the application of the superheated steam method to produce biochar. The biochar materials were then applied as an adsorbent to test its ability to treat industrial wastewater, particularly dye pollutants from the textile industry. Recycling agricultural by-products in this manner not only mitigates pollution but also contributes to the "zero waste" goal, promoting sustainable development and enhancing the value chain. The results obtained in this study were compared with other previously published materials, which showed superior dye removal efficiency when the maximum adsorption capacity for Methylene Blue and Rhodamine B was obtained at 146.3 mg/g and 82.4 mg/g. The lignin fractionation process also achieved high results when up to 74 - 76% of lignin content was fractionated from coconut husk and durian peel, showing that these are materials with good application potential.

Keywords: *Adsorption, agricultural by-product, biochar, circular bioeconomy, sustainable development, wastewater treatment*

1. Introduction

Recently, sustainable development has emerged as a pressing necessity for all economic sectors and a major global development strategy, particularly in the areas of environment and energy. The increase in global population, along with the increasing global energy demand and environmental issues related to oil, has promoted interest in biofuels or renewable energy to reduce dependence on crude oil and support carbon-neutral energy production (Haque et al., 2022). Agricultural waste is considered a potential renewable energy source with high development prospects. While both developed and developing countries, including Vietnam, are facing the challenge of handling large amounts of agricultural waste and by-products. In agriculture, the circular economy not only contributes to minimize negative impacts on the environment but also creates new valuable products with high value (Singh et al., 2022). The target net zero waste could be achieved together with increases in the value chain of the products.

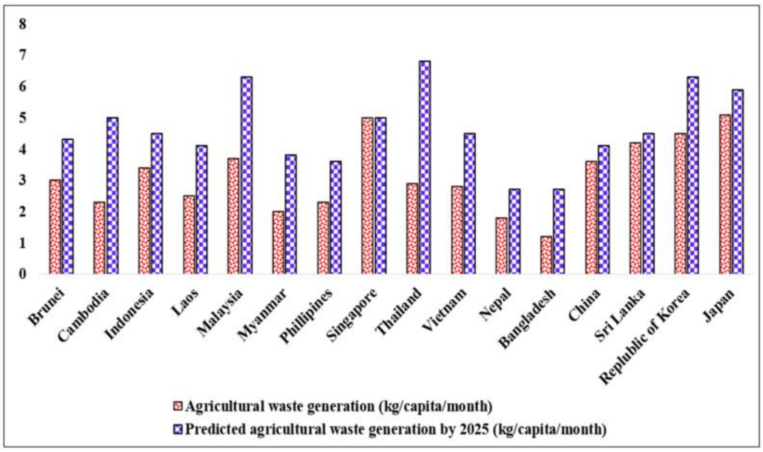

Figure 1: The average agricultural by-product amount generation in Asian countries 2023 – 2025

Source: Rex et al., 2023

Table 1: The valorization of agricultural by-products amongst sectors in Vietnam

	Rice	Shrimp	Catfish	Fruits
Production (ton)	43,448,200	899,840	1,420,000	8,800,000
Estimated amount of by-products	67,599,000 tons of rice straw, 11,000,000 tons of rice husk	35% of fresh weight, ca. 314,944 ton	70% of fresh fish weight, ca. 994,000 ton	50% of fresh fruit weight, ca. 4,400,000 ton
By-products types	Rice straw, rice husk, bran	Shrimp shell, shrimp head, wastewater, waste sludges	Head, skin, bone, fat, wastewater, waste sludge	Peel, pulp, seed, food waste, stems and leaves
Commercial products from by-products	Bio-fertilizer, animal feeding, mushroom substances, biological litter, handicraft…	Ingredients (Chitosan, Peptide), food, animal feeding, shrimp oil, fertilizer, renewable energy…	Ingredients (Collagen, Gelatin, enzyme), fertilizer, fish oil, animal feeding, renewable energy…	Fertilizer, biochar, medicine, food…

Source: Tu & Quan, 2021

The strong development of agriculture, combined with population growth and food consumption demand, has created a large amount of agricultural by-products that pollute the environment and contribute to climate change. The average quantity of agricultural by-products produced in Asian nations between 2023 and 2025 is depicted in Figure 1 (Rex et al., 2023). As can be seen, Japan is in the lead with 5.1 kg of agricultural byproducts produced per capita each month, while Bangladesh is the country with the least agricultural by-products at only 1.2 kg/person/month. In 2025, Thailand may overtake the top Asian countries and have had the largest increase in the production of agricultural by-products, roughly 2.5 times higher than 2023 situation. Singapore is considered the best country in terms of managing emissions into the environment when it is forecasted that by 2025, agricultural by-products of this country will remain unchanged compared to 2023. Vietnam is also forecasted to have a sharp increase in the amount of agricultural by-products by 2025 (about 1.5 times).

In Vietnam, the agricultural sector (including crop cultivation, forestry, aquaculture, and livestock) contributed 13.96% to GDP (Nguyen, 2021). Vietnam is the world's second-largest exporter of agricultural products, including rice and coffee etc...(Nguyen & Nguyen, 2024). However, these agricultural activities also generate a large amount of waste and by-products (30 – 70%). The valorization of agricultural by-products amongst sectors in Vietnam. The by-products such as rice straw and rice husk from rice production; shrimp shell and shrimp head from shrimp production; head, skin and bond of catfish from catfish production; shell, peel, pulp, husk, leave from fruit production are shown in table 1. The fruit production accounting for up to 50% of the total output due to the quantity of by-products released into the environment. Of those, the majority are two fruit varieties that are commonly farmed in Vietnam: coconut and durian. According to statistics in 2023, coconut output in Vietnam reached 1.9 million tons, equivalent to about 0.24 million tons of coconut husk waste discharged into the environment. While the Durian output was 1.2 million tons, equivalent to about 0.7 million tons of durian peel discharged into the environment (Chu, 2024). Therefore, recycling these agricultural by-products has great potential.

Coconut husk, one of the most common by-products of the coconut industry, has the main components of 48.85% cellulose, 16.19% lignin, and 26.04% hemicellulose, which is biodegradable and has the potential to be recycled into many useful products (Romão et al., 2022). Also, durian peel is a lignocellulosic material with cellulose, hemicellulose, and lignin ratios of 30.92%, 17.99%, and 7.69% respectively, which can be utilized for industrial and environmental purposes (Tran et al., 2022). Lignin is one of the main components in coconut husk and durian peel with a wide range of potential applications, including the production of biofuels, bioplastics, carbon fibers, and high-value chemical compounds such as vanillin and phenol (Wendisch et al., 2018). Lignin fractionation methods have developed through many stages, from traditional alkalization processes such as the Kraft and soda methods, to more modern methods such as the use of organic solvents and ionic liquids (Melro et al., 2020). The primary benefits and drawbacks of each approach are associated with the cost, the purity of the lignin that is produced, and the efficiency of the separation process. However, after successfully lignin fractionation, the remaining solid by-product also requires treatment and application to avoid emissions into the environment.

Currently, fabrication of biochar from biomass materials has received more attention. Calcination can be divided into 3 types: dry calcination, wet calcination and steam calcination, for biochar production. The calcination of biomass in anaerobic environment is the most used method, however, the limitations still remained such as low quality and high carbon loss. Chandana et al. reported that 80% of carbon is lost to the environment when calcination temperature is higher than 600 ^{o}C (Chandana et al., 2020). Since this wastes carbon and pollutes the environment, the superheated steam technique was created to preserve the material's carbon content. The advantage of this method compared to other conventional methods is fast and uniform heating thanks to direct contact with biomass. Therefore, superheated steam becomes a carrier gas, an ideal heat transfer medium to promote the biomass heating process, making the process faster and the resulting product more uniform (Cai et al., 2019).

Water pollution is becoming increasingly serious in many areas of Vietnam, especially due to the discharge of dyes, which has become an urgent environmental problem for countries like Vietnam and other developing countries. This difficult situation has been aggravated by the rapid development of the textile industry. Residual dyes can lead to serious health complications, including respiratory problems, digestive disorders, blindness, and brain damage (Yusuf, 2019). Therefore, the application of biochar material synthesized from agricultural by-products for industrial wastewater treatment is a circular economy solution towards the goal of “zero waste”.

The present study focusses on the development of new advanced materials utilizing agricultural by-products (durian peels and coconut husk) and their application for wastewater treatment. Firstly, the lignin fractionation from coconut husks and durian peel is performed. Secondly, the advanced material is developed from lignin fractionated pulp-based coconut husks and durian peels. Finally, the efficiency of industrial wastewater treatment is investigated.

2. Methods

2.1. Materials

Fresh coconut husk and durian peel were collected from a local market in Hanoi, Vietnam. After collection, the husks were washed with distilled (DI) water to remove dirt. They were then sliced and ground to a size of 0.3 mm. The samples were then dried at 80°C for 24 h and stored in an airtight container for further experiments.

The commercial activated carbon-based coconut shell was purchased from Tra Bac Company (Code TB04, Vietnam). All other chemicals were imported from Merk and used directly without further purification.

2.2. Lignin fractionation

The lignin fractionation was performed at Clean Energy Center, Korea Institute of Science and Technology. The pressure condition is 20 bar. The samples of coconut husk and durian peel obtained after lignin fractionation are denoted as CHF and DPF.

2.3. Carbonization

The crudely processed and preserved coconut husk and durian peel were activated with acid for 24 hours. The materials were then washed until the pH reached neutrality and dried at 80^{o}C for 24 hours. Finally, the materials were calcined in anoxic conditions at 800^{o}C for 1 hour using a furnace (SH Scientific, SH-FU-11MGE, Korea) with a heating rate of 75^{o}C/min to obtain materials denoted as BCH and BDP.

The process of calcining materials using superheated steam is carried out by taking samples of coconut husk and durian peel that have been roughly processed and preserved and calcining them in a kiln (TMAXCN, TMAX-1200C furnace, China) with a steam flow rate kept constant at 0.4 m^3/h. The calcination is carried out at a temperature of 300^{o}C for 1 hour, then the temperature is increased to 600^{o}C and calcined for another hour to obtain materials denoted as SCH and SDP. Commercial coal samples were also calcined using the above process to obtain a material sample denoted as SCB. The lignin fractionated pulp-based coconut husks and durian peels are also calcined in the same way as the above process, however, in stage 2 when increasing the temperature, they are calcined at 700^{o}C to obtain material samples denoted as SCHF and SDPF.

2.4. Adsorption experiment

Experiments to investigate the Methylene Blue (MB) and Rhodamine B (RhB) adsorption efficiencies of different materials were conducted by shaking a suspended mixture of 20 mg of adsorbent and 20 mL of MB solution (initial concentration, C_0 = 200 mg/L) or 20 mL of RhB solution (initial concentration, C_0 = 100 mg/L) in a 100 mL primary flask at 180 rpm for 24 h. After reaching equilibrium, the adsorbent was removed using a 25 mm nylon syringe filter with a pore size of 0.2 μm. The dye concentrations were measured using a UV-vis spectrophotometer (UV-VIS-NVIR, V-770, Jasco, Japan) at the maximum absorption wavelength of 662 nm for MB and 553 nm for RhB. The adsorption amount of dye (q, mg/g) was calculated according to Equation (1):

$$q = \frac{(C_0 - C_e) \times V}{m} \tag{1}$$

where C_0 is the initial concentration (mg/L), C_e is the equilibrium concentration of the dye (mg/L), V is the volume of dye (L) and m is the mass of the adsorbents (g).

3. Results and Discussion

3.1. Lignin fractionated

Table 2 shows the results of the fractionation efficiency analysis of the components from coconut husks and durian peels. For coconut husk, the fractionation efficiency of cellulose, hemicellulose, and lignin components was 10.3%, 75.9%, and 74.2% respectively compared to the initial amount, equivalent to the remaining solid containing 89.7% cellulose, 24.1% hemicellulose, and 25.8% lignin compared to the initial amount. Meanwhile, the fraction obtained from durian peel obtained 18.3% glucan, 74.1% xylan and 76.1% lignin, and thus the remaining solid will have glucan, xylan, lignin content of 81.7%, 25.9%, and 23.9% respectively. In general, for both coconut husk and durian peel, polysaccharides such as cellulose and glucan tend to be retained more in the solid part, demonstrating the high stability of these components in the natural structure. On the contrary, components such as hemicellulose, xylan, and lignin are easily separated during processing. In particular, lignin, when the ability to separate this component in both coconut husk and durian peel is quite high (74.2% from coconut husk and 76.1%

from durian peel). This creates a potential product when lignin, as a natural polymer, has great potential for application in many fields such as being used to produce biopolymer materials, adhesives, antioxidants, or as an adsorbent in environmental treatment thanks to its ability to adsorb heavy metals and pollutants (Mariana et al., 2021). In addition, lignin is also a potential source for the production of biofuels or high-value products through pyrolysis or biochemical processes (Lu & Gu, 2022). With high lignin fractionation efficiency from coconut husk and durian peel, this can be a sustainable recycled material source for modern industries.

Table 2: Fractionation results of components from coconut husk and durian peel

Compositions	Original	Lignin fractionated	
		Pulp	Fractionate
Coconut husks			
Cellulose (g)	22.3	20.0	2.3
Hemicellulose (g)	8.7	2.1	6.6
Lignin (g)	38.8	10.0	28.8
Unknown (g)	28.9	5.4	23.5
Total (g)	100	37.5	62.5
Durian peels			
Glucan (g)	25.7	21.0	4.7
Xylan (g)	8.5	2.2	6.3
Lignin (g)	26.4	6.3	20.1
Unknown (g)	39.4	8.7	30.7
Total (g)	100	38.3	61.7

Source: Vu et al.

3.2. Methylene blue adsorption test

The adsorption performance of the adsorbents for MB removal was then investigated. Figure 2 shows the MB adsorption amount by various materials synthesized from coconut husk, durian peel, and commercial biochar. All biochar materials show high affinity with MB ion, the high adsorption amount was obtained, $q > 40$ mg/g. In the cases of biochar derived from coconut husk, the adsorption amount was lower than that of commercial biochar (CB, $q = 65.2$ mg/g), except the biochar-based coconut husks-fractionated (SCHF, $q = 97.2$ mg/g). The adsorption amount order is SCHF > BCH > CHF > SCH. This result indicated that both lignin fractionation step and activation with superheated steam step are necessary for biochar fabrication. In the case of biochar derived from durian peels, all materials show higher MB adsorption amount than that of commercially activated carbon and biochar-based coconut husks. The biochar fabricated with anoxic and superheated steam condition, shows a higher adsorption amount than durian peel fractionated, but lower than that of combination of lignin fractionation and calcination with superheated steam (SDPF, $q = 142$ mg/g). The adsorption amount order is SDPF > BDP > SDP > DPF. This result agreed with coconut husk data, the highest adsorption amount was obtained for superheated steam-lignin fractionated samples. The lignin fractionation stage is therefore not only separation of lignin but also activation of solid phase. In the case of commercial biochar, the activated CB with superheated steam showed higher adsorption amount than normal commercial biochar. This further reinforces the fact that the superheated steam stage is necessary to improve material quality. Overall, biochar samples derived from durian peel showed superior MB adsorption capacity, while biochar samples synthesized from coconut husk and commercial biochar showed good application potential.

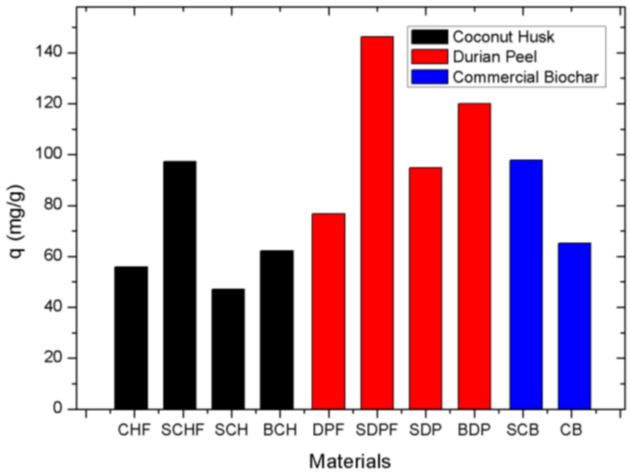

Figure 2: Adsorption of Methylene Blue with different materials

Source: Vu et al.

Table 3: Comparison of Methylene Blue adsorption amounts of different adsorbents

Material	Adsorption condition	Pollutants	*q* (mg/g)	References
SCHF	200 mg/L	MB	97.201	Present work
SCH	200 mg/L	MB	47.033	Present work
BCH	200 mg/L	MB	62.165	Present work
SDPF	200 mg/L	MB	146.300	Present work
SDP	200 mg/L	MB	94.847	Present work
BDP	200 mg/L	MB	120.00	Present work
SCB	200 mg/L	MB	97.739	Present work
CB	200 mg/L	MB	65.213	Present work
Coconut husk fiber	100 mg/L	MB	83.170	(AL-Aoh et al., 2014)
Coconut leaf	200 mg/L	MB	80.00	(Jawad et al., 2016)
Coconut tree bark	200 mg/L	MB	14.900	(Parvin et al., 2019)
Activated carbon based durian shells	500 mg/L	MB	57.450	(Tran et al., 2022)
Activated carbon prepared from durian shell	200 mg/L	MB	44.890	(Chandra et al., 2007)

Source: Vu et al.

The MB adsorption capacity of the materials in this study was compared with other previously published works (Table 3). The results showed that the materials SDPF, SDP, and BDP derived from durian peel in this study showed a higher adsorption amount than that of previously published studies. In particular, the material SDPF had an adsorption capacity 2.5 - 3.3 times higher than those materials activated carbon-based durian shells and activated carbon prepared from durian shell. Meanwhile, biochar-based coconut materials (SCHF, SCH, and BCH) also showed relatively good adsorption capacity compared to previously published studies. The SCHF in this study had the best adsorption capacity (q = 97.2 mg/g), higher than coconut leaf and coconut husk fiber-based activated carbon, and up to 6.5 times higher than the material coconut tree bark. SCB, a commercial biochar material activated by superheated steam, also shown a significant shift in adsorption capacity, which was higher than that of the majority of the studies that were examined. This further confirmed the effectiveness of the superheated steam heating process.

3.3. Rhodamine B adsorption

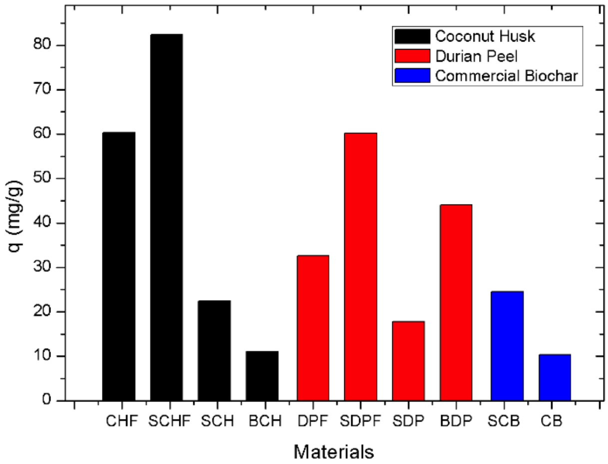

Figure 3: Adsorption of Rhodamine B with different materials

Source: Vu et al.

The RhB adsorption amount using various synthesized materials from coconut husk, durian peel, and commercial biochar were tested, as shown in Figure 3. The adsorptive removal of RhB could be achieved, all the synthesized materials-based coconut husks and durian peels showed higher adsorption amounts than the commercial sample (CB, q = 10.4 mg/g). The biochar-based coconut husk fractionated with superheated steam activated (SCHF) is the best adsorption for RhB adsorption, the highest RhB adsorption amount was 82.4 mg/g, followed by CHF material with a relatively good adsorption capacity, q = 60.3 mg/g. The adsorption amount order is SCHF > SHF > SCH > BCH. The results show that the combination between lignin fractionation and superheated steam will make the materials more effective, as mentioned above. In the case of materials derived from durian peel, the highest adsorption amount among these materials was also SDPF (q = 60.2 mg/g). In addition, DPF and BDP materials showed the potential to treat RhB when q > 30 mg/g. On the other hand, these results also showed that the efficiency of the superheated steam heating process was very good when the SCHF and SDPF samples had much higher adsorption capacity than the raw samples such as CHF, DPF and higher than the samples heated in anaerobic environment such as BCH and BDP. In addition, the efficiency of the superheated steam heating process was also shown in the difference in adsorption capacity between samples from commercial biochar when the SCB sample showed much better adsorption capacity than the raw CB material, the same as MB system.

Adsorption levels of the materials in this study were compared to previously published data in Table 4. The results show the superiority of the materials in this study in the ability to treat RhB. In particular, the SCHF material must be mentioned because this material has an adsorption capacity 6.6 times higher than both Fe-N co-modified coconut shell and Crude coconut fiber. In addition, the adsorption capacity of SCHF is also 3.8 - 5.5 times higher than the materials Active carbon from durian shell and Modified coconut coir pith. Materials such as SDPF (q = 60.2 mg/g) and BDP (q = 44.1 mg/g) also show better adsorption capacity than the material also derived from durian, Active carbon from durian shell (q = 21.5 mg/g). Finally, compared to the materials of previous investigations, the commercial biochar material employed in this study exhibited lower adsorption amount (q = 10.4 mg/g). However, after activation material by the superheated steam method, the adsorption amount was 2.4 times increased (q = 24.5 mg/g). This further shows that the efficiency of the superheated steam activation method is very good and has high potential for application.

Table 4: Comparison of Rhodamine B adsorption capacity of different adsorbents

Material	Adsorption condition	Pollutants	*q* (mg/g)	References
SCHF	100 mg/L	RhB	82.4	Present work
SCH	100 mg/L	RhB	22.4	Present work
BCH	100 mg/L	RhB	11.1	Present work
SDPF	100 mg/L	RhB	60.2	Present work
SDP	100 mg/L	RhB	17.8	Present work
BDP	100 mg/L	RhB	44.1	Present work
SCB	100 mg/L	RhB	24.5	Present work
CB	100 mg/L	RhB	10.4	Present work
AC from durian shell	50 mg/L	RhB	21.5	(Tanasale et al., 2014)
Fe-N co-modified coconut shell		RhB	12.4	(Li et al., 2022)
Crude coconut fiber	100 mg/L	RhB	13.0	(Nascimento et al., 2021)
Modified coconut coir pith		RhB	14.9	(Sureshkumar & Namasivayam, 2008)

Source: Vu et al.

4.Conclusion

The biochar material derived from agricultural by-product was used as adsorbents in this study to evaluate its efficiency in treating industrial textile wastewater. The results of this investigation demonstrated great dye removal effectiveness when MB and RhB maximal adsorption capacities were reached at 146.3 mg/g and 82.4 mg/g, respectively. In the case of biochar derived from durian peels, all materials show higher MB adsorption amount than that of commercially activated carbon and biochar-based coconut husks. The biochar-based coconut husk fractionated with superheated steam activated (SCHF) is the best adsorption for RhB adsorption, followed by CHF material with a relatively good adsorption capacity. When up to 76% of the lignin content was extracted from coconut husk and durian peel, the lignin fractionation technique likewise produced excellent results, indicating that they are materials with considerable application potential. It is believed that using durian peel and coconut husk as an absorbent material could be helpful in eliminating dye effluent and may be a practical way to make use of existing resources. By recycling agricultural by-products in this way, pollution is reduced, and the "zero waste" objective is furthered, along with sustainable development and value chain enhancement.

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A Review of Australian Circular Economy Policies and Suggestions for Vietnam

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Abstract

Given the increasing frequency and severity of climate change, there is a pressing need for countries to transition to a more circular economy to reduce carbon emissions and dependence on finite resources. Existing literature suggests that developing countries have opportunities to learn from developed nations in designing effective circular economy policies and legislation. Building on this premise, this paper examines key aspects of Australia's circular economy policies with the aim of providing recommendations for Vietnam. The findings suggest that Vietnam could benefit from developing a comprehensive action plan with specific targets for advancing the circular economy. This would also involve ensuring a consistent approach across all levels of government in implementing circular economy initiatives and considering the introduction of a government-led container deposit scheme with financial incentives to promote recycling efforts across the entire community.

Keywords: *Australia, circular economy, laws, policies, Vietnam*

1. Introduction

While having no official definition, circular economy (CE) is generally defined as an economy that operates on a spiral-loop system, minimising energy consumption, material use, and environmental harm while still promoting social, technological, and economic development (Geng & Doberstein, 2008). In light of the goal to achieve net-zero emission targets in the near future, CE has become a topic of interest among many scholars and practitioners. A Scopus query with the term "CE" conducted in August 2024 returned more than 36,500 documents. Among these, more than 26,500 documents (approximately 73 percent) were published between 2021 and 2024, suggesting the concept has particularly gained traction in recent years in academia. For policymakers around the world, the topic of CE has also emerged as a priority. However, there is a noticeable gap in the attention given to the CE between developing and developed countries. Of 160 papers on CE published from 2006 and 2019, only 5 percent focus on developing countries (Kirchherr & van Santen, 2019). Halog and Anieke (2021) share the same view and argue that developing countries can adopt some existing policies in relation to CE from developed countries to solve their waste mismanagement problems.

This paper critically examines the comparative strengths and weaknesses of CE policies in Australia and Vietnam, with the aim of identifying key policy gaps in Vietnam's CE framework. By drawing lessons from Australia's more established CE policies, the research seeks to provide actionable insights and recommendations for strengthening Vietnam's approach to sustainable economic development through CE practices. This study contributes to the broader discourse on global policy transfer and the transition to a CE.

The rest of the paper proceeds as follows. Section 2 outlines the methodology used to gather studies for the policy review and describes how the analysis was conducted. Section 3 presents the findings from the policy analysis, focusing on: (i) Australia's circular economy (CE) laws, highlighting their advantages and disadvantages; and (ii) Vietnam's current efforts to promote the circular economy, examining their strengths and limitations to identify gaps in Vietnam's policies. Section 4 offers recommendations for Vietnam based on Australia's experience, and Section 5 provides the conclusion of the paper.

2. Methods

Due to certain constraints, this paper presents a high-level literature review based on desktop research, focusing on the laws and policies of Australia and Vietnam regarding the CE. On the Australian side, the review encompasses policies from all three tiers of government (federal, state, and local), with a particular emphasis on waste management policies, as Australia has identified effective waste management as a key driver in the transition to a CE. In terms of Vietnam, the paper provides an overview of the current CE policies of the Communist Party of Vietnam, followed by an analysis of the challenges faced during the implementation of these policies.

3. Results

3.1. Australia's transition to a circular economy

3.1.1 Summary of circular economy laws in Australia

The Australian Federal Government is committed to transitioning to a more CE by 2030 by working with the private sector to design out waste and pollution as well as keep materials in use**.** To achieve this goal, the government has made an effort to support the waste management sector nationally, an integral component within the CE. A significant component in this regard is the introduction of the updated National Waste Policy in 2018. This policy acknowledges the need for Australia to shift towards a circular economy and determined CE principles for waste as follows (Commonwealth of Australia, 2018):

1. Avoid waste
2. Improve resource recovery
3. Increase the use of recycled material and build demand and markets for recycled products
4. Better manage material flows to benefit human health, the environment and the economy
5. Improve information to support innovation, guide investment and enable informed consumer decisions.

Following this, the National Waste Policy Action Plan 2019 was released to set out the following seven national targets and according actions to implement the 2018 National Waste Policy (Commonwealth of Australia, 2019):

1. Ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020
2. Reduce total waste generated in Australia by 10 per cent per person by 2030
3. 80 per cent average resource recovery rate from all waste streams following the waste hierarchy by 2030
4. Significantly increase the use of recycled content by governments and industry
5. Phase out problematic and unnecessary plastics by 2025
6. Halve the amount of organic waste sent to landfill by 2030
7. Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions

The above policies have influenced a number of policies in different states and territories across Australia, particularly those around plastic uses. Specifically, South Australia was the first state or territory in Australia to ban single-use plastic straws, cutlery and stirrers in March 2021, following the passing of the Single-use and Other Plastic Products (Waste Avoidance) Act 2020 (Green Industries SA, 2021). Queensland, the Australian Capital Territory, New South Wales and Western Australia have since followed suit with similar Acts. Although Tasmania has not enacted an official law yet, it has proposed banning single-use plastic items that are already prohibited in at least one other Australian state or territory (Department of Natural Resources and Environment Tasmania, 2024).

To assist the community with recycling on a daily basis, governments of all levels in Australia also establish transparent standards around the recycling bins. Each colour indicates a specific type of waste or material that should be disposed of in the corresponding bin (NSW Environment Protection Authority, 2024). In addition, at the local government level, most municipalities provide a range of posters and signs to help the residents manage their garbage and recycling (City of Melbourne, 2024).

Table 1: The colour-coding system of bins in Australia

Waste category	Bin body colour	Bin lid colour
Garbage	Dark green or black	Red
Recycling (commingled or containers)	Dark green or black	Yellow
Paper and cardboard	Dark green or black	Blue
Organics (including co-collected food and garden organics)	Dark green or black	Lime green

Source: NSW Environment Protection Authority (2024)

Figure 1: City of Melbourne's recycling poster

Source: City of Melbourne (2024)

Another major initiative to promote a circular economy by all state and territory governments in Australia is the container refund scheme, which aims to reduce litter and boost recycling efforts. This program enables the public to gather eligible empty drink containers and bring them to a refund point, where they will receive 10 cents for each container. Notably, participants can opt to keep the refund to themselves through bank transfer or store vouchers or support their chosen charities or community organisations with a donation. The container refund scheme is known in each state and territory as follows:

- Victoria: Victoria's Container Deposit Scheme
- New South Wales: Return and Earn
- Queensland: QLD Containers for Change
- Tasmania: Recycle Rewards
- Northern Territory: NT Container Deposit Scheme
- ACT: ACT Container Deposit Scheme
- South Australia: SA Container Deposit Scheme
- Western Australia: WA Containers for Change

In February 2023, the Australian government consolidated its commitment to the CE transition by establishing the Circular Economy Ministerial Advisory Group. This Advisory Group is responsible for advising the Minister for the Environment and Water on CE-related issues with evidence-based research and consultation (Department of Climate Change, Energy, the Environment and Water, 2024).

3.1.2 Strengths and limitations of Australian circular economy laws

Australia's CE laws have several advantages. Firstly, it is clear that to enable and accelerate the implementation process of circular economy laws, the Australian government has produced a clear action plan. This has been proved successful with many initiatives and programs being rolled out by governments at lower levels. Secondly, despite its self-governing states and territories, Australia has successfully unified efforts to transition to a CE. While each jurisdiction governs its CE laws independently, consistent recycling strategies are being introduced nationwide. This uniform approach extends to the municipal level, with councils actively promoting recycling through educational initiatives for local residents. Thirdly, Australia has shown that recycling can be further encouraged with a financial incentive with the container deposit scheme as an example. The Australian container deposit scheme has been proved effective in encouraging people to recycle more, with New South Wales and Queensland seeing a 30 per cent and 35 per cent reduction in beverage container litter respectively within the first year of implementation (Exchange for Change, 2018; Containers for Change Queensland, 2019). Additionally, the scheme delivers substantial community benefits, as many residents choose to donate their refund money to charities. Non-profit organisations also view the scheme as an important fundraising tool, helping them raise funds from the community for various good causes. The economic case of the container deposit scheme has also been justified in the state of Victoria with a benefit-cost ratio of 1.33. This means for every $1 dollars invested in the program, the expected dollar benefits generated is $1.33. The most significant benefit of the scheme is its impact on litter reduction, with an estimated benefit of $725.1 million over a 20-year period (Department of Environment, Land, Water and Planning Victoria, 2022).

It is worthwhile to note that Australia's adoption of the CE laws is not flawless. Halog et al. (2021) note that Australian CE laws are more conservative than those of European countries due to the country's small yet dispersed population and reliance on resource extraction through the mining industry. Moreover, since state governments in Australia hold primary responsibility for environmental management, it is evident that different states adopt varying approaches and timelines in addressing environmental issues. This variation can create challenges for governance, particularly in terms of coordinating reporting and monitoring outcomes, and may also result in inconveniences for residents relocating between states.

3.2. Vietnam's circular economy legal framework

3.2.1. Summary of circular economy initiatives and policies in Vietnam

In Vietnam, the development of a CE has been recognised as a pivotal strategy for proactively addressing climate change, ensuring sustainable management, optimising resource utilisation, and safeguarding the environment. In light of the party's perspectives and policies, and guided by the spirit of the 13th National Congress' resolution on circular economy development, many legal documents related to CE have been issued such as:

First, regarding the general regulations on CE

The concept of CE is recorded in Clause 1, Article 142 of the Law on Environmental Protection 2020: *"Circular economy is an economic model in which design, production, consumption and service activities aim to reduce the exploitation of raw materials and materials, extend the product life cycle, limit waste generation and minimise negative impacts on the environment"*. The concept of CE only defines a single goal but does not capture the nature of CE as raw material that must be designed and operated continuously in closed cycles. Decree No. 08/2022/ND-CP provides specific guidance on CE in Articles 138, 139 and 140.

The general criteria for a CE are outlined in Clause 1, Article 138 of Decree No. 08/2022/ND-CP as follows:

"a) Reduce the exploitation and use of non-renewable resources, water resources; enhance the efficiency of resource, raw material, and material usage and promote energy conservation;

b) Extend the use of materials, equipment, products, goods, components, structures;

c) Limit waste generation and minimise negative impacts on the environment including: reducing solid waste, wastewater, emissions; reducing the use of toxic chemicals; recycling waste, recovering energy; reducing single-use products; green shopping."

Vietnam's approach to the CE has primarily focused on environmental protection. There is a significant lack of specialised legal regulations related to promoting the circular economy (CE), with the topic of CE only being sporadically addressed in some documents. These include Article 3, Article 16 of the

Investment Law 2020; Decree No. 82/2018/ND-CP dated May 22, 2018 of the Government on management of industrial parks and economic zones; Law on Enterprises 2020; Law on Support for Small and Medium Enterprises 2017; Article 11 of the Law on Technology Transfer 2017; Law on Intellectual Property 2005 amended and supplemented in 2022.

Second, regarding the economic instruments in relation to environmental protection and the transition to a CE

The Law on Environmental Protection 2020 recognises the pivotal role of economic instruments in environmental management in Section 1, Chapter XI. Specifically, this is mentioned in Article 91 (Reduction of GHG emissions), Article 136 (Policies on environmental protection taxes and fees), Article 137 (Payment of deposits on environmental protection), Article 138 (Payment for natural ecosystem services) and Article 140 (liability insurance against environmental damage).

Third, regarding the incentive mechanism to promote CE

The Vietnamese government prioritises investment in developing a CE law through a number of projects such as: Decision 2178/QD-TTg dated December 21, 2020 of the Prime Minister: Approving the Project "Completing the database of natural resources and environment connected with information systems, databases of ministries, branches, localities"... Organisations and individuals engaged in activities and projects that implement the CE model are eligible for incentives and support, including investment incentives, tax benefits, fee and charge reductions, subsidies for environmental protection products and services, promotion of green credit, and encouragement of green bonds. The government encourages other CE-related activities as stipulated in Clause 3, Article 140 of Decree No. 08/2022/ND-CP such as: Researching and developing technology and technical solutions, Developing models of linkage and sharing the circular use of products and waste; Applying measures industrial symbiosis in accordance with the provisions of law on management of industrial parks and economic zones; International cooperation, exchange of experience, knowledge, and technology on a circular economy in accordance with the provisions of law, etc.

Fourth, regarding the law enforcement institutions that promote CE

The Vietnamese government is responsible for overseeing the entire economy, including the transition to a CE. Ministries, ministerial-level agencies, and provincial People's Committees are tasked with state management in promoting CE within their respective fields and localities, fostering close coordination in implementation. The Ministry of Natural Resources and Environment is responsible for submitting the National Action Plan for implementing CE regulations to the Prime Minister for promulgation and plays a pivotal role in advancing CE initiatives.

Fifth, regarding the regulatory measures to ensure the enforcement of CE laws

The dissemination and propaganda of CE is assigned to the entire political system, in which the government plays a core role according to Clause 1, Article 3 of the Law on Dissemination and Education of Law 2012. The responsibilities of enterprises, communities, households, individuals, mass organisations, and officials working to promote a CE are mainly reflected in the Law on Environmental Protection 2020.

3.2.2. Strengths and limitations of Vietnamese circular economy laws

Recent developments in CE initiatives have yielded notable successes in Vietnam. Various economic models that align with CE principles, such as garden-pond-cage, forest-garden-pond-cage, garden-pond-lake, eco-industrial parks, and cleaner production, have emerged across the country. Following the implementation of a pilot eco-industrial park model between 2015 and 2019 in four industrial parks (Khanh Phu, Gian Khau in Ninh Binh; Hoa Khanh in Da Nang; Tra Noc 1 and Tra Noc 2 in Can Tho), the Ministry of Planning and Investment has, since 2020, continued collaborating with UNIDO to replicate this model in additional locations such as Hai Phong, Dong Nai, and Ho Chi Minh City. As a result, 603 resource efficiency and cleaner production (RECP) solutions were proposed in three industrial parks: Hiep Phuoc (Ho Chi Minh city), Amata (Dong Nai), and Dinh Vu (Hai Phong) (Tạp chí Công thương, 2024).

Progress has also been made in reducing the exploitation of non-renewable resources and promoting the use of renewable energy and raw materials. The Ministry of Natural Resources and Environment has actively shut down outdated mineral extraction and processing facilities that contribute to environmental pollution, thereby supporting the sustainable exploitation and processing of minerals and advancing the pillars of the circular economy (Diệu Thúy, 2019).

In terms of renewable energy, by the end of 2020, Vietnam's total renewable energy capacity reached approximately 6,000 MW, with 5,290 MW coming from solar power and 500 MW from wind power. The electricity generated from renewable sources increased to about 8 billion kWh, accounting for 2.53 per cent of the total national electricity output in 2020 (Đình Bảng, 2021).

Efforts to improve household waste collection and implement effective waste sorting at the source have also seen progress. According to the Hanoi Department of Construction, the household solid waste collection rate in the city reached 85.5 per cent, with a daily collection volume of 7,300 tons. This rate varies by area, with central districts achieving 100 per cent collection, while suburban districts reach 88-89 per cent. All collected waste is treated according to standards, with most of the waste processed at the Nam Son Waste Treatment Complex (about 5,500 tons/day) and the Xuan Son Solid Waste Treatment Area (about 1,500 tons/day) (Đình Hà, 2023).

In Da Nang City, a pilot project to classify solid waste at the source was initiated in 2017 in the Thuan Phuoc and Thach Thang wards, sponsored by the Japan International Cooperation Agency (JICA). By June 2018, over 80 per cent of residential areas had implemented waste sorting, and by 2019, Da Nang achieved a 100 per cent waste collection rate, the highest in the country (Bộ Tài nguyên và Môi trường, 2021).

The official recognition of the CE model in party and state policies and guidelines, particularly through its legalisation, provides a strong foundation for further advancing CE initiatives in the future. Vietnam is one of the first countries in the ASEAN region to include regulations on CE in the Law on Environmental Protection. The country's adherence to international commitments and bilateral and multilateral treaties such as CPTPP, EVFTA has fostered favourable conditions for advancing CE development. However, the existing legal framework for CE remains fragmented and unsystematic, dispersed across various legal documents.

A primary obstacle in implementing the CE model in Vietnam is the relative novelty of the CE regulations within the 2020 Law on Environmental Protection. Existing regulations often lack coherence between environmental laws and those governing land, investment, enterprises, taxes, and technology, hindering the promotion of CE development projects. Current legal documents pertaining to CE development primarily address principles and orientations, necessitating the establishment of specific regulations and guidelines for implementation. The development of comprehensive systems of standards, institutions, enforcement mechanisms, monitoring, and evaluation for each industry and field requires substantial resource investment and time. Moreover, current regulations have not effectively incentivized innovation and creativity in production, nor have they fostered a strong sense of social responsibility among individuals and organisations to achieve the objectives of a CE.

Second, there is a lack of policy mechanisms to promote the CE, such as the concretisation of Extended Producer Responsibility (EPR), tools, and investment incentives. There are no sufficient incentives for businesses through resource taxes, environmental protection fees, support for technology access, or worker training. Furthermore, the absence of effective linkages between businesses and manufacturers complicates the product consumption phase. Specific regulations are also lacking to guide businesses, industrial parks, cities, and various sectors in implementing CE models across all stages of the process. The CE framework includes stages such as design, reuse, sharing, repair, refurbishment, remanufacturing, and recycling to create closed loops within the CE model (Nguyễn & Hồ, 2024).

Third, Vietnam lacks businesses with sufficient technological capacity to recycle and reuse products, and small and medium-sized enterprises face challenges in investing in technological innovation. Additionally, information systems, data, and sharing mechanisms are inadequate for monitoring and evaluating progress toward CE goals.

Fourth, achieving a correct understanding of the CE requires consensus and unity from leaders, management levels, enterprises, and individual citizens. Additionally, infrastructure and industrial park planning geared toward a CE, as well as overall connectivity, remain limited. Many fragmented plans stem from linear economic development thinking, which lacks integration and fails to align with resource balancing and sustainable resource use.

Fifth, the implementation of the CE is hindered by the absence of an organisational system, highly qualified human resources, a comprehensive data information system, and a mechanism for inspecting and supervising progress. Therefore, there is a need for a dedicated agency to coordinate the implementation of CE plans. Vietnamese law lacks a clear and specific mechanism for managing implementation, focusing only on coordinating the development and issuance of a framework to guide and evaluate progress. It does not address the inspection and supervision of relevant actors (Trần et al., 2024). Moreover, resources for transitioning to a CE remain inadequate. Successful CE development must be linked to scientific innovation and access to advanced technology. Additionally, the development of a CE requires a team of skilled experts capable of addressing challenges throughout the entire process.

Finally, several environmental protection policies lack the necessary conditions for effective implementation, such as support for waste collection and management in rural areas, the use of biogas, clean production, and community-based resource management. Additionally, existing tax and fee regulations are not well-suited to practical needs. The tax rates under the 2009 Law on Natural Resources Tax prioritise the regulation of high-value resources, particularly through the rates applied to non-metallic minerals and crude oil, without adequately addressing the need to limit resource exploitation or promote environmental preservation.

4. Recommendations for Vietnam’s CE legal framework based on the Australian case

Drawing from key aspects of Australia’s CE policies, this paper proposes three recommendations for Vietnam with potential for practical implementation.

First, Vietnam should introduce a national-level policy to promote the transition to a CE. This policy should not only highlight the importance of a CE but also establish clear action plans and specific targets for Vietnam to achieve within a defined timeframe.

Second, there should be an alignment among lower levels of government in the implementation of CE initiatives. While municipalities, provinces, and even individual cities and towns may develop their own initiatives and programs to promote the transition to a CE, it is crucial that all levels of government maintain a unified direction, regardless of the specific policies adopted. Furthermore, drawing lessons from the challenges posed by the varied timelines for CE policy adoption across Australia’s states and territories, which complicate the monitoring and reporting process, it is imperative that Vietnam’s administrative units synchronise their timelines for CE regulations to ensure consistency and efficiency.

Third, Vietnam should consider implementing a government-led container deposit scheme to encourage residents to recycle on a daily basis. Many residents in Vietnam have already been involved in recycling plastic containers and papers through informal waste workers who collect and sell these materials in the country. However, this process has been occurring with little to no guidance from the government, leading to a lack of structure and consistency in how plastic and paper items can be recycled. Therefore, it is recommended that the government should intervene to centralise the item collection for recycling in Vietnam and offer monetary incentives in exchange for recycled items from the residents.

5. Conclusion

This paper offers a comprehensive review and evaluation of Australia's current CE policies. It also summarises key Vietnamese policies that support the CE concept before identifying limitations in Vietnam's existing legal framework for CE development. These limitations encompass, but are not limited to, a dearth of policy mechanisms to promote the CE, a scarcity of businesses with the capability and capacity to recycle and reuse products, and a lack of consensus understanding of the CE among policymakers and civilians.

The study subsequently suggests that many of Australia's policy strengths can serve as valuable lessons for Vietnam to inform the improvement of its own CE legal framework. Key recommendations for Vietnam are that Vietnam should establish a comprehensive CE policy, ensure consistency across government levels, and offer financial rewards to encourage public participation in recycling.

Future research should consider expanding the scope of this study to include case studies from other countries and potentially conduct a quantitative analysis of relevant CE data.

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The Current Situation of Circular Agriculture Model Implementation in Vietnam

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Abstract

The article explores various circular economy models in agriculture in Vietnam to understand and study the effectiveness and challenges of their implementation. By analyzing data from previous studies, conducting field surveys, and interviewing farmers directly, the results show that typical circular agricultural models such as Garden - Pond - Livestock, rice - shrimp, rice - fish, and 4F have yielded positive outcomes. All models contribute to increasing productivity, income, and reducing production costs; however, there are still many barriers and limitations to implementation. Analyzing the current state of the circular agriculture model serves as a basis for proposing appropriate policies and solutions to comprehensively develop the circular economy model in Vietnam, aimed at responding to global climate change.

Keywords: *Circular agriculture, current situation, solutions*

1. Introduction

Climate change is becoming one of the biggest challenges of the 21st century, profoundly affecting every aspect of economic and social life worldwide. Vietnam, with its diverse terrain and unique geographical location, is among the countries most affected by climate change. Over the past two decades, Vietnam has witnessed an increase in the frequency and intensity of extreme weather events such as storms, floods, and droughts, causing serious damage to the economy, particularly in the agricultural sector. This sector not only plays a central role in the national economic structure, but is also the primary source of income for millions of rural people, but under the influence of climate change, agriculture faces a decline in productivity and sustainability due to the negative impact of climatic change (Tran, 2017).

In light of that alarming situation, the transition from a linear economic model to a circular economic model is seen as a sustainable solution that minimizes negative impacts on the environment and conserves natural resources. Circular economy in agriculture or circular agriculture contributes to reducing emissions in agricultural production, combating waste, enhancing economic efficiency, and protecting ecosystems. Vietnam's commitment at COP 26 to achieve net-zero emissions by 2050, in which circular agriculture is one of the key sectors to fulfill this commitment.

The article focuses on analyzing the current state of circular agriculture development in Vietnam, including the policies, models being implemented, and the results achieved. At the same time, the article will clarify the existing challenges and propose specific solutions to promote the transition to circular agriculture, contributing to the fulfillment of international commitments and moving towards sustainable development.

2. Methods

To clarify the current situation of implementing the circular economy model in agriculture in Vietnam, the author has collected and analyzed data from various sources across the country. The research process involves collecting secondary data from primary documents such as reports from the Ministry of Agriculture and Rural Development, Statistical Yearbooks, government decrees, and published research works. These documents provide an overview of the policies, strategies, and actual outcomes of implementing the circular economy model in agriculture in Vietnam. In addition, the author also conducted surveys and interviews with farming households that are implementing this model. This approach will help gather practical, detailed information about the techniques, economic efficiency, as well as the challenges that people face in the process of implementing the circular economy model.

The collected data was then processed and analyzed using content analysis methods, in order to comprehensively assess the aspects related to the circular economy model in agriculture. Through the research process, I have synthesized and analyzed the achieved results, as well as identified the existing challenges. The research results have contributed to providing insights into the current situation and offering recommendations to improve and promote the circular economy model in agriculture in Vietnam.

3. Results

3.1. Garden - Pond - Livestock Model (VAC Model)

The Garden-Pond-Pen (VAC) model is an integrated farming system that combines gardens, ponds, and livestock pens, widely applied in Vietnam. This model helps optimize resource use and enhances resilience to the environment. Compared to traditional farming models, this model brings higher economic efficiency, saves costs, and minimizes environmental impact. VAC is increasingly receiving attention and a higher level of application due to its potential to mitigate the impacts of climate change and improve rural livelihoods.

Positive effects result from the garden-pond-livestock paradigm, which can strengthen agricultural systems' resistance to climate change. By optimizing production efficiency and establishing a vast ecosystem, the model helps farmers become better equipped to adapt to and recover from climate change-related events like droughts and flooding. The integration of agriculture, aquaculture, and animal husbandry results in a closed-loop system that produces nutrients from organic fertilizers rather than synthetic ones and helps recycle resources by using waste from one product as an input for another.

Hanh (2022) research shows that farmers in Hai Phong applying the VAC model have significantly improved their income, with some households reaching up to 200 million VND per year. This source of income is thanks to the diverse products from the VAC system, which includes agricultural products such as fruits, fish, and livestock. This is evidence that the VAC model significantly contributes to improving economic efficiency in the local area.

The Lang Son province's experience with the VAC model's efficacy further validates its importance for long-term economic success. The local cooperatives have adapted different VAC models to the specific needs of the region, giving farmers a reliable source of income and bringing hygienic agricultural products to the market (Tuan et al., 2020); Lang Son Newspaper, 2023). According to Mr. Hoang Van Giang, a member of the cooperative, “By participating in the cooperative, I have been guided in livestock breeding and cultivation techniques through practical models, which helps me apply them effectively in my work.” Thus, the VAC model not only prevents epidemics but also enhances the productivity and quality of agricultural products. The adaptability of the VAC model to various environmental and economic conditions makes it a versatile tool for rural development in Vietnam.

The Garden - Pond - Livestock model is a comprehensive method for sustainable agricultural development in Vietnam, providing economic benefits. This concept helps farmers improve rural economies by combining several farming techniques into a single, cohesive system that not only increases productivity but also helps mitigates the effects of climate change. With intentions to keep raising sustainability and productivity in Vietnam's agriculture industry, this model has been updated and applied to numerous areas of the nation in recent years. The effectiveness of the VAC model will be enhanced by research and policy support to fortify and expand it, guaranteeing the model's viability and sustainability as a cornerstone for sustainable rural development.

3.2. The Garden - Pond - Livestock - Forest Model (VACR Model)

The garden is a model developed from the traditional garden model, applied in the mountainous provinces of Vietnam. The combination of agriculture, livestock farming, aquaculture, and forestry demonstrates the circular economic relationship within the model. VACR includes the main components: garden (growing vegetables and fruit trees), pond (aquaculture), barn (raising livestock), and forest (planting forestry trees), thereby creating a closed ecosystem where each part is interconnected to enhance production efficiency and promote the sustainable use of natural resources.

The effectiveness of VACR can be inferred from similar models such as VACB (Garden - Pond - Livestock - Biogas). According to the Low Carbon Agricultural Support Project (2013-2019) funded by ADB, the application of livestock waste separation technology in the VACB model has yielded significant results. Households with a scale of over 2,000 pigs can obtain about 1 ton of pressed manure each time they run the machine, with a selling price ranging from 800,000 to 1 million VND. The farm owner has an additional income of tens of millions of dong per month from applying this technology. Farms tend to scale up, such as the farm in Cam Xuyen, Ha Tinh, which has expanded from 3,000 to 7,000 pigs.

Despite the progress made, there are still numerous obstacles to overcome before the VACR model may be fully expanded. First off, it is challenging to use the model in different regions because of its distinctiveness, which is dependent on the geographical features of the region. Furthermore, compared to other manufacturing sectors, environmental remediation technology in the cattle business frequently has a lower profit margin.

The development of sustainable agriculture has a lot of promise in Vietnam’s hilly regions because to VACR. Government policy implementation that promotes farmer investment and strengthens their access to technical support and training, together with technology research and development appropriate for local conditions, are required to replicate this strategy. With proper support, VACR can significantly enhance sustainable agriculture, boost farmer incomes, and save the environment.

Participants have given the VACR model a positive evaluation on its efficacy. A farmer in Tan Ky district, Nghe An, stated, “My family has not only improved our income but also protected the living environment thanks to the application of the VACR model.” That is proof of the VACR model’s beneficial effects on boosting economic efficiency, raising revenue, and promoting the community’s sustainable growth.

3.3. The rice-shrimp, rice-fish model

The rice-shrimp and rice-fish models have been widely implemented in the delta regions of Vietnam, such as the Mekong Delta and the Red River Delta, and have developed specific cultivation characteristics for each area. This model was established in the 2000s in the Mekong Delta provinces, particularly in Kien Giang Province. Shenzhen with a sea area of 63,290 km² and a coastline longer than 200 km (Do, 2010; Wỏld Bank, 2016) is a favorable condition for implementing the rice-shrimp and rice-fish models. Meanwhile, in the Red River Delta, this model is being implemented in the low-lying and flood-prone provinces. The model above is a testament to the ability to adapt to climate change and protect the environment, while also providing economic improvements for farmers.

Ca Mau, one of the provinces dealing with a more severe case of climate change and seawater intrusion, needs workable methods to deal with this issue. This region has encouraged the paradigm of rice agriculture coupled with shrimp farming, resulting in an environmentally friendly ecosystem and increasing productivity. It has significant potential for seafood, particularly shrimp. In 2021, more than 40,000 hectares, or 14% of the province's total shrimp farming area, were under the rice-fish and rice-shrimp paradigm. According to the Department of Agriculture and Rural Development of Kien Giang (2023), the largest area, Thoi Binh district, made up 48.7% (19,500 hectares) of the province’s shrimp-rice area).

The German Development Cooperation (GIZ) report claims that there are still numerous obstacles facing the shrimp-rice concept in Ca Mau. Poor rice cultivation efficiency results from the regions used for shrimp and rice production not being carefully planned with irrigation infrastructure. Due to this, a large number of farmers have switched from rice to shrimp monoculture, which raises the danger of disease and modifies environmental markers for soil and water. Furthermore, this farming approach lacks international norms and sustainable practices, instead relying mainly on the experience of individual farmers.

To address these issues, since December 2021, GIZ has collaborated with the Department of Agriculture and Rural Development of Ca Mau Province and the People's Committee of Thoi Binh District to implement the development of technical guidelines for organic farming and pilot projects on 12 households in Bien Bach Dong Commune, Thoi Binh District. The intervention measures in the production process have yielded positive results after two farming cycles, with shrimp productivity increasing by 25% and average profits rising by 20% compared to households using the old model, reaching 36.6 million VND/ha per year.

In Bac Lieu, the transition from an ineffective rice cultivation model to a combination of shrimp farming and rice cultivation has been implemented since the 2000s, resulting in significant progress. The rice - shrimp model yields effective results, achieving nearly 7 tons per hectare, which is double that of traditional rice cultivation methods. Thanks to this model, many localities north of National Highway 1A have experienced significant development, with infrastructure and living conditions for the residents greatly improved. From an initial area of about 5,800 hectares in 2001, the rice-shrimp farming area in Bac Lieu has now exceeded 40,000 hectares, demonstrating the effectiveness and sustainability of the model (Department of Agriculture and Rural Development of Kien Giang, 2023).

The rice - shrimp and rice - fish models have proven their adaptability and outstanding economic efficiency, especially in the context of climate change in the Mekong Delta. In Kien Giang, this model has helped improve the economic conditions of the people while also protecting the environment (Trang et al., 2018). However, to maintain and enhance the effectiveness of this model in the future, advanced research and technical solutions are needed to address challenges such as water quality management and disease control.

3.4. Biological farming model 4F (Farm - Food - Feed - Fertilizer)

The 4F model (Farm - Food - Feed - Fertilizer) in Vietnam is a pioneering initiative in applying the circular economy to the agricultural sector, aiming for sustainable development and environmental protection. The 4F biosecure livestock complex project, which has appeared for the first time in Vietnam, marks an important step in realizing the goal of producing clean and safe agricultural products.

This initiative finances the purchase of chemical-free organic feed and biological product factories, as well as a biosecurity-assured pig farm. The feed production plant can produce up to 100,000 tons annually, while the bio-product manufacturing plant has a 50,000 tons annual capacity. Building organic feed and product factories seeks to establish an organic farming network, reduce environmental damage, and supply consumers with clean agricultural products.

The pig farming facility, one of the first completed projects, covers an area of 2 hectares and is equipped with modern automation technology. This farm has the capacity to raise between 8,000 to 10,000 pigs for meat each year, while also producing around 3,000 to 3,500 disease-free breeding pigs, ensuring high quality to meet the demand for herd development and provide quality organic meat for the market (Que Lam Group, 2020). Thua Thien Hue uses the 4F model, which includes biological production facilities and a sizable pig farming enterprise, over a 15-hectare area. The Que Lam Group's Chairman of the Board of Directors, Mr. Nguyen Hong Lam, confirmed that the project is being coordinated with scientists from around the world to propose the best solutions when applying the model to improve economic efficiency, fight climate change, protect the environment, and match the real-world circumstances in Vietnam's livestock industry.

In addition, Vinamilk has also implemented the 4F model in its farm system through the Vinamilk Green Farm project. This project not only focuses on producing clean raw fresh milk but also optimizes the value chain from cultivation, livestock feed production, to waste treatment for organic fertilizer production. Vinamilk has established internationally certified farms, combining advanced technology with the 4F model to ensure that dairy products meet the highest quality standards while minimizing negative impacts on the environment. The Vinamilk Green Farm project is a prime example of the successful application of the 4F model in the field of livestock and milk production, contributing to the sustainable development of Vietnam's agricultural sector (Vinamilk, 2023).

By applying the 4F model in both pig farming and milk production, Vietnam is gradually asserting its position in the field of circular agriculture, contributing to environmental protection and sustainable development.

3.5. The model of rice cultivation - mushroom farming - organic fertilizer production - fruit tree planting

The model of combining rice cultivation, mushroom farming, organic fertilizer production, and fruit tree planting is a notable initiative in sustainable agriculture in Vietnam. This model maximizes the use of available resources in agricultural production, helping to minimize waste, increase economic value, and improve product quality. The application of this model not only brings direct economic benefits to farmers but also contributes to environmental protection and sustainable development.

The organic rice cultivation model combined with mushroom farming and organic fertilizer production has proven to be highly effective in increasing farmers' income. According to Trung (2022) states that after each rice harvest, straw is collected and used as a material for mushroom cultivation. Mushrooms, after being harvested, not only provide a source of high-quality food but also generate a stable income for the people, increasing to tens of millions of dong each year. The straw left after mushroom cultivation is processed into organic fertilizer, which is then used to fertilize fruit trees, creating a closed-loop cycle in agricultural production.

In addition, the use of biological products to convert straw into organic fertilizer also helps improve soil quality, increase fertility, and minimize the use of chemical fertilizers, thereby protecting the environment and human health. Fruit trees grown on soil improved with organic fertilizers not only yield high productivity but also possess superior quality, effectively meeting domestic consumption and export demands. The success of this model has been adopted by many localities in Vietnam, especially in the Mekong Delta provinces, where the supply of straw after rice harvest is very abundant (Hau Giang Newspaper, 2023).

The model of rice cultivation - mushroom farming - organic fertilizer production - fruit tree planting is a clear testament to the development of circular and sustainable agriculture in Vietnam. By optimizing resource use and minimizing waste, this model not only helps farmers increase their income but also protects the environment and enhances the quality of agricultural products. Continuing to expand and develop this model will positively contribute to the sustainable development of Vietnamese agriculture in the future.

4. Conclusion

4.1. The barriers to developing the circular agriculture model in Vietnam

In response to the reality of climate change, environmental degradation, and the depletion of natural resources due to the destruction of nature and overexploitation of natural resources, the circular economy and circular agriculture, or regenerative agriculture, are optimal solutions that yield positive results and are prioritized for development worldwide. Vietnam is a country with a tradition of agriculture, while also facing significant pressures from environmental issues; therefore, the development of circular agriculture is an inevitable direction for the country's agricultural sector. However, the application and development of the circular economy model in Vietnam still face significant barriers.

Firstly, the lack of supportive policies and legal frameworks. The lack of opportunities, financial support, tax policies, or incentives from the Government is a barrier to investing in environmental sectors. (Studer et al., 2006). Currently, the regulations on the application of circular economy in Vietnamese agriculture still have many shortcomings, scattered across various documents, and there is no clear guiding system (Vasilenko & Arbačiauskas, 2012; Lawrence et al., 2006).

Secondly, fragmentation and disunity of land is a significant barrier to the development of circular agriculture. Short-term land use rights, along with small rice field areas, limit farmers' ability to accumulate land and make long-term investments. (World Bank, 2016). The market for agricultural land leasing services is still underdeveloped, and the land valuation process faces many obstacles, making it difficult to consolidate farmland.

Indeed, the awareness of agricultural entities regarding the role of the circular agriculture model is still limited. Many farmers still prioritize yield by using chemical inputs instead of adopting sustainable agricultural models. (Trianni & Cango, 2012; Rademaekers et al., 2011). This reduces the effectiveness of the transition to a circular agriculture system.

4.2. Recommendations

Circular agriculture has shown significant potential to enhance the efficiency and sustainability of the agricultural sector in Vietnam. However, currently, the implementation of this model still faces several issues, such as an incomplete legal framework, fragmented policies, insufficient technological advancement, and inadequate awareness among farmers. The following specific solutions should be focused on to address these issues and promote the development of circular agriculture:

Firstly, the legal framework and policies supporting circular agriculture need to be completed. Legal documents must be amended and supplemented to clearly specify the standards and development roadmap for circular agriculture. The government should establish specific regulations regarding what businesses and farmers must do when collecting, processing, and reusing agricultural waste. At the same time, there is a need for policies that encourage businesses to invest in environmentally friendly and green technologies.

Secondly, promote the parallel development of science and technology with circular agriculture. What is essential is to invest in research and the development of waste treatment technologies, renewable energy, and organic agriculture production. In addition, it is necessary to invest in research and the development of new technologies, while also encouraging developed countries to transfer technology. In addition, it is essential to establish demonstration models related to circular agriculture so that farmers can apply their knowledge in practice.

Thirdly, viewing circular agricultural development as an inevitable trend for Vietnam in response to the severe impacts of climate change. In this context, circular agriculture must develop in a nature-friendly direction, adapting to the specific conditions of the country. Set tasks and challenges for building a production model, and research appropriate policies to achieve effective development.

Fourthly, raise social awareness about circular agriculture, especially among agricultural stakeholders, linking the development of circular agriculture with education and training. Open regular training classes for the people, disseminating knowledge and methods about circular agriculture and waste treatment measures so that each farmer can effectively implement the model. In addition, developing short-term training courses at educational and vocational institutions; integrating programs and projects on sustainable agricultural development.

Fifthly, leverage and mobilize all social resources for circular agriculture. Develop strategies, objectives, legal frameworks, and enhance public understanding of circular agriculture, establishing a trend for the development of circular agriculture nationwide.

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SECTION III

GREEN FINANCE AND ACCOUNTING

Factors Affecting Green Credit Development – A case study at Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)

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Abstract

Implementing Vietnam's National Strategy and Action Plan on Green Growth, the State Bank has issued the Banking Industry Action Plan to implement the National Strategy on Green Growth to 2020 (Decision No. 1552/QD-NHNN dated August 6, 2015) and pay special attention to green credit as shown in Directive 03/CT-NHNN dated March 24, 2015 on promoting green credit growth and risk management. environmental and social risks in credit granting activities, credit institutions need to proactively develop green credit programs and policies to gradually increase the proportion of green credit in the credit investment portfolio structure. applications and develop and implement environmental and social risk management solutions in credit granting activities. The article uses qualitative and quantitative research methods to test the regression model of 5 factors affecting green credit development using SPSS 26 software, a case study at Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV). Results show that there are 5 factors affecting green credit development: (1) Policy institutions, (2) Banking technology, (3) Financial capacity, (4) Human resources, (5) Risk management. From the research results, the author proposes solutions to enhance green credit development at the Joint Stock Commercial Bank for Investment and Development of Vietnam.

Keywords: *Green bank, green credit, green credit development*

1. Introduction

The global trend has moved away from the traditional linear economic model and toward circular economic model solutions, which aim to promote sustainable production and consumption development while also protecting the environment. In keeping with that trend, the bank's initiatives support sustainable development, lower carbon emissions, preserve natural resources, and encourage environmentally beneficial activities. Reducing emissions in accordance with credit policies is encouraged by banks and other financial institutions, who also urge firms to enter into energy- and environmentally-saving agreements. Green credit is that. Banks can contribute to environmental protection indirectly through green lending. In order to attain sustainable growth, the Vietnamese banking sector also continuously aims to provide green credit and green banking.

Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV) - a state-owned commercial bank with a key role in the Vietnamese banking system and a strategic orientation of "green banking" However, besides the achievements, there are still some limitations such as: the growth rate of green credit is not strong, the proportion of green credit is still very modest to achieve strong development stronger, in-depth research is needed, from which practical solutions can be proposed to develop green credit at Vietnamese joint stock commercial banks in general and at Joint Stock Commercial Banks for Investment and Development of Vietnam (BIDV) in particular.

2. Litarature review

Green Finance is one of a number of terms used to label activities that involve a two-way interaction between the environment and finance and investment. Related terms include: responsible investment (RI), environment, social and governance, sustainable finance and climate finance. According to the definition of UNEP (2016): green finance involves the diversification of financial products and services provided by financial institutions towards the sustainable development of the country. In addition, green finance is also defined as financial support aimed at green growth through meaningful reductions in greenhouse gas emissions and environmental pollution (Xiaowei et al., 2021).

Green credit is an inevitable trend of the global financial industry, an effective solution in preventing and limiting the increasingly negative impacts of climate change. Developing green credit helps banks limit environmental and social risks in business activities. Policy institutions related to the environment as well as bank lending policies help green credit develop (Derbali, 2021); Phan et al., 2021). Phan et al. (2021) also believe that Banking Technology involves the application of new technologies to create important breakthroughs in implementing new modern banking services, meeting the needs of customers. diverse needs of customers. Human are the central factor. If a bank's business activities are to be increasingly expanded, it is necessary to have a team of dedicated bank officials, with a high sense of responsibility and professional knowledge. (Nguyen & Le, 2021). According to Nguyen (2023), green credit development depends on specific regulations and definitions of green categories and sectors; policies to support green credit development; awareness and capacity of commercial banks.

3. Methods

3.1. Data collection

Research data was collected through survey questionnaires sent to customers who have been using green credit products at the Joint Stock Commercial Bank for Investment and Development of Vietnam. According to Hair et al. (2021), the smallest sample size should be 50, preferably 100, and the ratio of observations/measured variables should be 5/1. The research model is built with 5 factors measured through 24 observed variables, so the minimum number of samples is 120. From 150 customer surveys, after collection and screening, there are 135 valid surveys left. The collected data are encrypted and used SPSS26 software for analysis. To measure factors affecting green credit development at Joint Stock Commercial Bank for Investment and Development of Vietnam, with a 5-level Likert scale: 1- Strongly disagree; 2- Disagree; 3- No opinion; 4- Agree; 5- Completely agree.

3.2. Research model

From the results of previous studies, the author builds a model of factors affecting green credit development with 5 factors: *(1) Policy institutions, (2) Banking technology, (3) Financial capacity, (4) Human resources, (5) Risk management.*

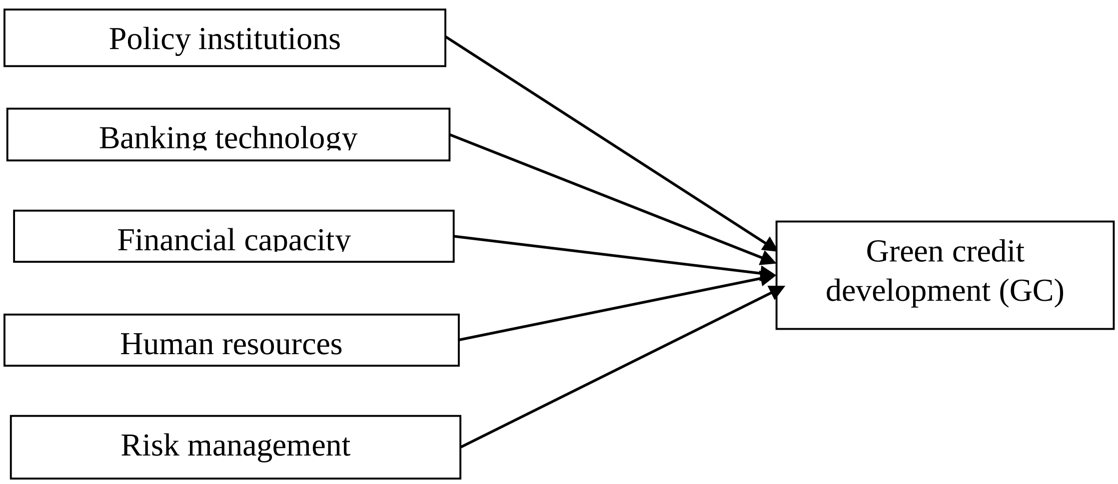

Figure 1: Research model

Source: Compiled by the author

Research model with research hypotheses:

H1: Policy institutions have a positive impact on green credit development

H2: Banking technology have a positive impact on green credit development

H3: Financial capacity have a positive impact on green credit development

H4: Human resources have a positive impact on green credit development

H5: Risk management have a positive impact on green credit development

4. Results

4.1. Descriptive statistical results

The author conducted data processing and data analysis on 135 valid survey questionnaires obtained. The initial descriptive results are obtained:

Table 1: Description of general information of the research sample

		Frequency	Ratio (%)
Gender	Female	98	72.59
	Female	37	27.41
Age	Under 40 years old	56	41.48
	From 41 to 59 years old	48	35.56
	Up to 60 years old	31	22.96
Academic level	university bachelor	62	45.93
	post-university degree	73	54.07
Use of green credits at a certain level	Not yet used	62	45.93
	Have ever used	38	28.15
	Using	35	25.93

Source: Compiled by the author

Through the descriptive statistics table, it can be seen that the level of green credit usage at BIDV is not high, and many customers do not know the concept of green credit. Therefore, identifying factors affecting green credit at BIDV is very important. On the basis of preliminary processed data, the author conducted an analysis of factors affecting green credit development at BIDV.

4.2. Cronbach's Alpha test

All Cronbach's alpha coefficients of the variables were ≥ 0.6, thus meeting the requirements to be included in factor analysis. At the same time, the total correlation coefficients of the observed variables all meet the requirement of ≥ 0.3, ensuring that the given scales can be trusted in a statistically significant way.

Table 2: Reliability Statistics

	Scale Mean if Item deleted	Scale Variance if Item deleted	Corrected Item – Tota Correlation	Cronbach's Alpha if Item deleted
CS	11.267	8.253	.762	.836
CN	11.104	8.812	.629	.825
TC	11.412	8.375	.758	.817
NL	11.725	8.069	.780	.836
QT	11.471	8.427	.684	.852

Source: Compiled by the author

4.3. Exploratory factor analysis (EFA)

The data is tested using KMO = 0.764 (> 0.5), and the Sig of Bartlett's Test is 0.000, less than 0.05. These results demonstrate that the observations are correlated and fully consistent with factor analysis. The observed variables' factor loading factors are all greater than 0.5, the extracted total variance is 73.65% (greater than 50%), and the Eigenvalue coefficient is 1.461 (greater than 1).

The exploratory factor analysis was warranted for these tests. As a result, all of the scales chosen for the model's variables satisfy the criteria and are suitable for use in further research.

4.4. Results of regression analysis

The results of the multivariate regression analysis of the study are as follows:

Table 3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	Model	Sig.
		B	Std. Error	Beta		
	Constant	3.328	.021		113,523	.000
	CS	.261	.036	.426	10,883	.000
	CN	.195	.031	.283	6.823	.000
	TC	.064	.023	.142	6.269	.002
	NL	.084	.024	.186	4.949	.000
	QT	.135	.028	.276	5.410	.000
a. Dependent Variable: GC						

Source: Compiled by the author

The results of the regression analysis of the model of factors affecting with 5 independent variables are as follows: Model fit test value sig. = 0.000 (< 0.05 shows that the variables in the model can explain the change in the dependent variable.

$$GC = 0.426*CS + 0.283*CN + 0.142*TC + 0.186*NL + 0.276*QT + \alpha$$

In which: GC is the dependent variable - Green credit development

Independent variables: CS (Policy Institution), CN (Banking Technology), TC (Financial Capacity), NL (Human Resources), QT (Risk Management), all have an influence on the secondary variable belonging to different levels.

From the results of regression analysis and standardized regression equation, we see that there are 5 factors that have a positive relationship with green credit development at BIDV, in which the factor "Policy institutions" has the most impact on the system with Beta number = 0.426.

5. Conclusion

Creating green credits is one of the most important things to do in light of the global climate change that is occurring. The State Bank has acknowledged in recent years how critical it is for the banking and financial sectors to actively participate in advancing risk awareness and the "greening" of the economy. The atmosphere in which financial operations take place is getting higher. The State Bank and BIDV must both put a number of policies and initiatives into place in order to support the growth of green credit in Vietnam.

To provide uniform direction and implementation throughout the banking system, soon to be released are circulars and guidelines on environmental and social risk management in credit-granting activities.

Banks must make sure that workplace amenities including conference rooms, offices, and office supplies are fully furnished and comfortable for staff members. A welcoming and comfortable workspace can foster increased innovation and output.

Keep up the good work encouraging foreign financial institutions and organizations to contribute to the funding of green fields and projects by bringing in and mobilizing capital. For the purpose of advancing knowledge, abilities, and ethical standards, commercial banks must consistently train and develop their human resources in green credit. In order to support credit work and credit risk management more efficiently, easily, and expertly, banks must swiftly establish a credit information database.

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The Impact of Corporate Social Responsibility on Financial Performance of Small and Medium Enterprises in Vietnam: Moderating Role of Digital Transformation

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Abstract

This study investigates the impact of Corporate Social Responsibility (CSR) on the financial performance of Vietnamese SMEs using a PLS-SEM model. We examine reputation, customer satisfaction, and competitive advantage as mediating variables, and digital transformation as a moderator. Data from 312 SMEs reveals significant correlations between all variables and firm performance. Customer satisfaction emerged as the strongest influence. Interestingly, digital transformation weakens the CSR-performance relationship. Based on these findings, recommendations are provided for both government and businesses to enhance CSR understanding, optimize digital transformation strategies, and create value-aligned business goals.

Keywords: *CSR, digital transformation, firm performance, SME.*

1. Introduction

Corporate social responsibility (CSR) has been widely researched and applied in business practices in developed countries over the past decades. In Vietnam, the issue of CSR implementation is increasingly receiving the attention of businesses, especially when Vietnam is becoming a destination for foreign direct investment (FDI), opening up development opportunities for domestic small and medium enterprises (SMEs). If Vietnamese businesses want to cooperate with large FDI enterprises, they need to comply with CSR requirements and clearly disclose them. Thus, Vietnamese businesses need to pay attention to improving the effectiveness of CSR implementation to meet the requirements of foreign businesses and consumers.

The term "Corporate Social Responsibility" first appeared in the research of Bowen (1953), the author said that it is intended to propagate and call on managers not to have a negative impact on the interests of society. Above all, the responsibility of businesses must be towards compensating for society's losses. Torugsa et al. (2011) affirm that although SMEs are subject to many resource constraints, proactively implementing CSR, which is understood as the application of business strategies and practices to manage social responsibility voluntarily surpassing mandatory legal requirements, still brings financial success to the business. Proactively implementing CSR is a necessary value creation strategy, because it exploits limited resources most effectively, thereby helping businesses maximize financial profits.

Identifying and measuring mediating and moderating variables influencing the CSR-firm performance relationship is crucial, as previous research often overlooks these factors. While studies have pinpointed mediators such as competitive advantage, reputation, customer satisfaction, and innovation (Saeidi et al., 2015; Martinez-Conesa et al., 2017), recent research introduces digital transformation as a potential moderator in this relationship. Fu and Li (2023) support this by demonstrating digital transformation's role in enhancing the positive impact of CSR on firm performance and fostering sustainable business growth.

Despite growing corporate interest in Corporate Social Responsibility (CSR), the concept remains relatively unfamiliar to the general Vietnamese public. This limited understanding poses a significant challenge to the widespread adoption of CSR practices. As Torugsa et al. (2011) observed, while some businesses have prioritized CSR initiatives, there is a substantial gap in awareness and implementation across the broader business landscape, particularly among small and medium-sized enterprises.

Another critical limitation in the existing body of research is the narrow focus on specific industries and geographic areas. While some studies have examined CSR within particular sectors or regions, a comprehensive understanding of CSR's impact across diverse industries and geographical contexts in Vietnam is lacking. As Nguyen (2010) pointed out, many studies have been constrained by the specific requirements of foreign buyers, limiting their generalizability. Consequently, there is a pressing need for broader research to capture the nuances of CSR implementation and its outcomes across different industries and regions within Vietnam. A persistent challenge in CSR research is the inconsistency of findings regarding the relationship between CSR and financial performance. While numerous studies have suggested a positive correlation, the overall evidence remains inconclusive. The varied results across different studies highlight the complexity of the relationship and the need for further investigation to establish a more definitive understanding of the impact of CSR on financial performance. From current research and practice gaps, the research team proposed to carry out the research topic *"The impact of implementing corporate social responsibility (CSR) on the performance of small and medium-sized enterprises in Vietnam: the moderating role of digital transformation."*

2. Literature review and Hypothesis development

2.1. Measuring CSR performance through ESG

CSR through ESG is to measure customer perceptions about these activities in each group of environmental, social and corporate governance factors. However, previous academic studies have shown that measuring ESG performance is difficult because it includes many different categories and aspects, some of which are difficult to quantify (Chelawat and Trivedi, 2016). An ESG score may also lack consistency and measurement criteria due to its non-financial attributes. Relying solely on self-reports or firms' surveys has shortcomings due to self-reporting bias. Even with quantified data, CSR performance is difficult to compare across businesses and periods.

However, because the context in Vietnam is still quite limited, the above scales have not been used to make investment or management decisions in our country. Although the VNSI - Vietnam Sustainability Index (Vietnam Sustainability Index) has been developed based on absorbing and calibrating modern ESG scales globally, this index still has some disadvantages because it only counts stocks listed on HOSE. Therefore, within the scope of this research article related to SMEs, to be more appropriate, the authors use the measurement of CSR implementation based on the perceptions of business administrators about the activities carried out by businesses, divided into each group of environmental (E), social (S), and governance (G) factors.

2.2. The relationship between corporate social responsibility and firm performance

CSR has a direct impact on firm performance

The direct impact of CSR on firm performance has been proven in many previous studies. Waddock and Graves (1997) showed that CSR implementation has a positive relationship with firm performance. Most recent studies in SMEs also show similar results when considering the relationship between these two factors. According to Choongo (2017), through implementing CSR activities such as reducing electricity and water consumption, SMEs in Zambia have cut costs, thereby improving firm performance. Research results by Juarez (2017) confirm that social CSR and economic CSR have a positive relationship with firm performance. Therefore, the research team proposed the following hypothesis:

H1: There is a direct and positive relationship between CSR implementation and firm performance.

CSR influences firm performance through corporate reputation

Many studies have shown that by implementing CSR, businesses can strengthen their reputation. Research by Cegarra-Navarro et al. (2016) suggests that SMEs are incorporating elements related to CSR into their corporate policies, thereby improving their image and perceived values such as corporate reputation among stakeholders. Gallardo-Vázquez et al. (2019) concluded that strategically guiding CSR implementation in SMEs helps enhance corporate reputation. Business reputation can become an effective competitive advantage, which in turn benefits firm performance. Therefore, the research team proposed the following hypothesis:

H2: There is a positive relationship between CSR implementation and corporate reputation.

H3: There is a positive relationship between corporate reputation and firm performance.

CSR influences firm performance through customer satisfaction

CSR aspects are agents of business actions that respond to society's need for business to be a good business (Carroll and Shabana, 2010). This includes the participation of SMEs in programs that encourage contributions to human welfare (Carroll, 1991). Previously, these activities have been shown by researchers to have an impact on customer needs, leading to high levels of customer satisfaction (Galbreath, 2010). Companies that engage in volunteer activities are often considered socially responsible if they meet community expectations and will be liked by the community (Jamali and Mirshak, 2007; Wood, 2010). A company's charitable contributions and the activities it engages in for community development are positively related to customer satisfaction, ultimately leading to revenue growth anh retained customers (Lev et al., 2010). Therefore, the research team proposed the following hypothesis:

H4: There is a positive relationship between CSR implementation and customer satisfaction.

H5: There is a positive relationship between customer satisfaction and firm performance.

CSR influences firm performance through competitive advantage

Many studies suggest that one of the core motivations for using CSR in strategy is the opportunity to make a business stand out from its competitors (Porter and Kramer, 2006) and grow its profits (Lee and Heo, 2009). Studies in the US context have focused on examining the benefits derived from implementing CSR (Levy and Park, 2011) and identifying how CSR contributes to important customer behaviors. However, other contexts need to be considered, especially emerging economies (Gao, 2011; Vong and Wong, 2013), specifically in non-service manufacturing and product creation industries for SMEs (Xun, 2013). In this regard, Nasir et al. (2015) pointed out that the majority of studies in the current economic context focus on information disclosure and expressed a need to focus on CSR activities and their impact on the competitive advantage of businesses. Therefore, the research team proposed the following hypothesis:

H6: There is a positive relationship between CSR implementation and competitive advantage.

H7: There is a positive relationship between competitive advantage and firm performance.

Moderating role of digital transformation

Some studies have shown that digital transformation factors have a moderating impact on business activities. Two researchers Yang and Guo (2022) concluded that the implementation of digital transformation has a moderating effect on the level of influence of suppliers in enterprise risk taking. That means suppliers in companies that have implemented digital transformation have increased the risk-taking level of businesses, while this impact is not significant in companies that have not yet implemented digital transformation. In the research of Fu and Li (2023), the influence of ESG and on firm performance is more prominent when the level of digital transformation of that enterprise is high. Based on the above analysis, the research team proposes the following hypothesis:

H8: Digital transformation has a moderating impact on the relationship between CSR and firm performance.

Through the theoretical analysis above, and based on the research model of Saeidi et al. (2015), the team proposed the following research model as indicated in the Figure 1.

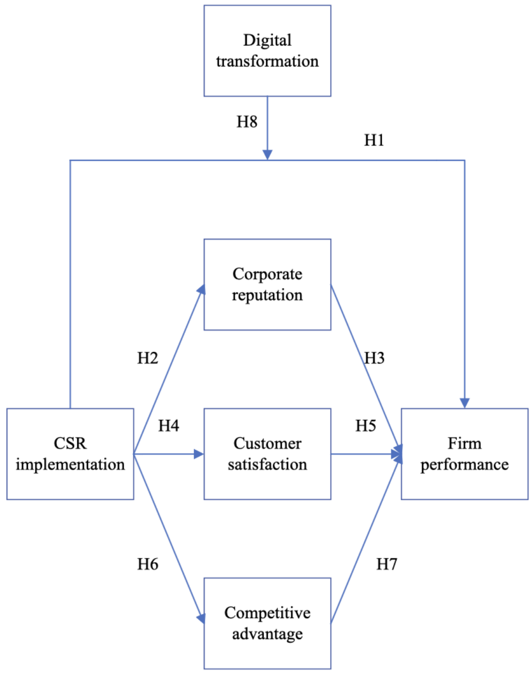

Figure 1: Proposed research model

Source: Compiled by the research team

3. Methods

Quantitative research was conducted using primary data obtained from the questionnaire to analyze variables in the model using structural model analysis and partial least squares measurement model (PLS- SEM). Based on the research topic of the authors, PLS-SEM is suitable in the following situations: (1) Limits issues related to small sample size and data are not normally distributed; (2) Estimate complex research models with many intermediate, latent and observed variables, especially structural models; (3) Suitable for research projects with a prediction orientation (Nguyen, 2016). From there, the results of testing the scale, model and research hypotheses are presented.

3.1. Development of questionnaires and measurement scales

The research scales were built based on foundation from previous research works and combined with references from experts to suit the target audience of SMEs in Vietnam. The study used a simple random sampling method. The survey is designed on a 5-point Likert scale with meanings from 1 - Completely disagree to 5 - Completely agree.

Specifically, the CSR scale according to E (CSR_E) includes 4 variables (Bahta et al., 2021), the CSR scale according to S (CSR_S) includes 5 variables (Bahta et al., 2021; Ikram et al., 2019), the CSR scale according to G (CSR_G) includes 3 variables, the Corporate Reputation scale (REP) includes 3 variables (Saeidi et al., 2015), Customer Satisfaction (CS) scale includes 5 variables, Competitive Advantage (CA) scale includes 3, Digital Transformation (DT) scale includes 4 variables, Firm Performance scale (FP) includes 5 observed variables (Saeidi et al., 2015). The quantitative test results show that the above questions are all statistically significant and consistent with the model.

3.2. Research sample

Due to time and cost constraints, the authors could not conduct a survey of all businesses nationwide. The research sample was conducted on a group of businesses. The survey targeted businesses in many provinces across all three regions of the country to ensure data collected was diverse and accurate. This approach allows the research team to obtain a representative sample of businesses and draw conclusions that are applicable to the entire business.

The larger the sample size, the higher the reliability. Hair et al (2014) stated that the sample size must be at least 150 to produce highly reliable model results. After conducting the survey, the research team received 378 completed forms. The authors conducted filtering, eliminating unreasonable answers and retained 312 forms.

4. Results

4.1. Individual item reliability

Cronbach's Alpha and composite reliability are used to evaluate the reliability of the scale. The two measure the internal consistency of observed variables in the scale, indicating the degree of correlation between observed variables in the parent factor. The scales all have Cronbach's Alpha > 0.7 and composite reliability > 0.7, so they are not eliminated (Devellis, 2012; Bagozzi and Yi, 1988). Thus, the scales ensure reliability and are eligible for use in subsequent quantitative analysis.

4.2. Convergent validity

To evaluate convergence, the authors used outer loadings and average variance extracted. Outer loadings of the observed variables > 0.7, so the observed variables are of good quality and meaningful in the model (Hair et al., 2016). The average variance extracted ≥ 0.5 indicates that the parent latent variables on average explain more than 50% of the variation of the child observed variables. The value of the average variance extracted meets the requirements. Thus, the observed variables reach convergent values.

Table 1: Cronbach's Alpha, composite reliability, smallest outer loadings and average variance extracted of the scale

	Cronbach's Alpha	Composite Reliability	The Smallest Outer Loadings	Average Variance Extracted
CA	0.863	0.912	0.746	0.778
CS	0.938	0.953	0.852	0.801
CSR	0.943	0.950	0.706	0.614
CSR*DT	1.000	1.000	1.130	1.000
CSR_E	0.921	0.944	0.892	0.808
CSR_G	0.867	0.919	0.851	0.791
CSR_S	0.907	0.931	0.771	0.731
DT	0.910	0.937	0.861	0.787
FP	0.879	0.913	0.742	0.679
REP	0.834	0.899	0.818	0.749

Source: Compiled by the research team

4.3. Discriminant validity

The assessment of the scale's discrimination is based on the basis of the average intra-scale correlation coefficient being larger than the average of cross-correlation coefficients. In the proposed research model, CSR is a second-order variable, so the discrimination for this variable is not evaluated but only between first-order variables. According to the results, the square root of AVE is higher than the correlation of other factors in the same column and HTMT < 0.9, so the discrimination of the scale is established (Hair et al., 2016).

Table 2: Fornell - Larcker and Heterotrait-monotrait ratio (HTMT)

	Fornell - Larcker						Heterotrait-monotrait ratio					
	CA	**CS**	**CSR*DT**	**DT**	**FP**	**REP**	**CA**	**CS**	**CSR*DT**	**DT**	**FP**	**REP**
CA	0.882											
CS	0.416	0.895					0.416					
CSR* DT	-0.148	-0.041	1.000				0.149	0.045				
DT	0.411	0.431	-0.070	0.887			0.403	0.450	0.073			
FP	0.628	0.769	-0.173	0.655	0.824		0.673	0.824	0.185	0.733		
REP	0.538	0.355	-0.134	0.434	0.564	0.865	0.567	0.371	0.132	0.485	0.637	

Source: Compiled by the research team

4.4. Standardized coefficients of the structural model

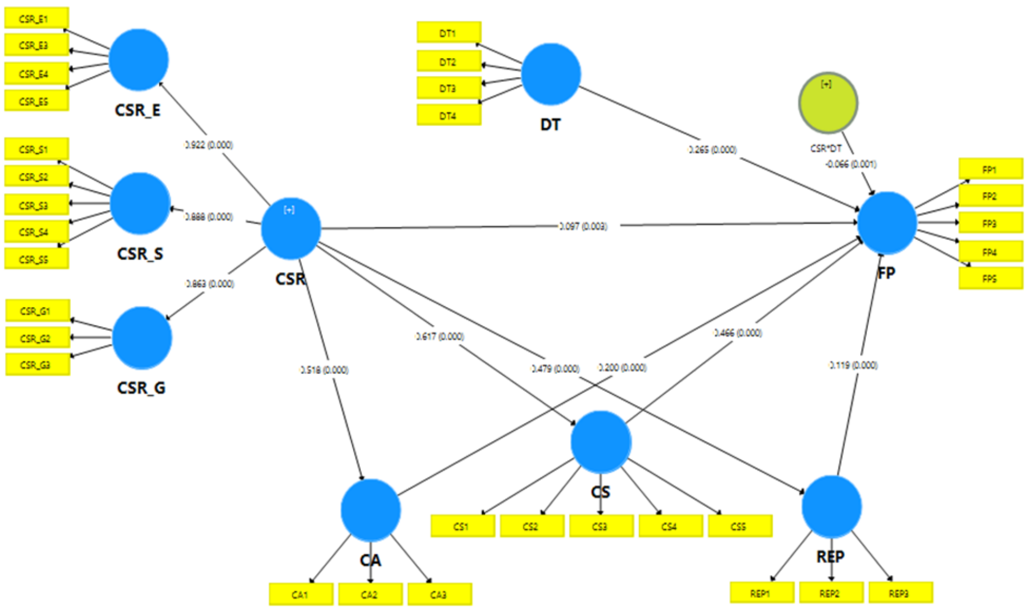

Figure 2: Diagram of impact relationships

Source: Summary of the research team

4.5. Bootstrapping test and Multicollinearity test

To test the impact relationships in the research model, the authors used Bootstrapping 5000 analysis and obtained the following results, as indicated in the Table 3.

The data in Table 3 show that all impact relationships in the model have P Values coefficients less than 0.05, so these relationships are all statistically significant. VIF value < 3, indicating that the model does not have multicollinearity (Hair et al., 2019).

As for the impact of CSR Implementation on the intermediate variables Corporate Reputation (REP), Customer Satisfaction (CS) and Competitive Advantage (CA), the standardized coefficients of the three variables are 0.479, 0.617, 0.518 respectively. Thus, CSR has a positive impact on the variables REP, CS, and CA. Notably, CSR Implementation is closely correlated with Customer Satisfaction, showing that nowadays social issues are not only a concern of companies but also of the whole community.

Regarding the impact of factors on the dependent variable Firm Performance (FP), not including moderating variables, there are four variables that impact on FP: CSR Implementation (CSR), Corporate Reputation (REP), Customer Satisfaction (CS) and Competitive Advantage (CA). The standardized coefficients of these four variables are 0.097, 0.119, 0.466, 0.200 respectively. Thus, all variables have a positive impact on FP with the level of impact in descending order being CS, CA, REP, CSR.

The study found that the impact of CSR implementation on firm performance has the lowest correlation in the model. This is explained because the mediating and moderating variables have adjusted this relationship, making the influence of the independent variable on the dependent variable no longer significant. Saeidi et al. (2015) study also showed similar results.

Table 3: Results of regression coefficients of impact relationships in the model

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	VIF
CA -> FP	0.200	0.031	6.373	0.000	1.652
CS -> FP	0.466	0.035	13.465	0.000	1.699
CSR -> CA	0.518	0.039	13.223	0.000	1.000
CSR -> CS	0.617	0.034	18.299	0.000	1.000
CSR -> FP	0.097	0.033	2.949	0.003	2.099
CSR -> REP	0.479	0.047	10.222	0.000	1.000
CSR*DT -> FP	-0.066	0.020	3.356	0.001	1.045
DT -> FP	0.265	0.028	9.616	0.000	1.491
REP -> FP	0.119	0.035	3.415	0.001	1.587

Source: Summary of the research team

For the moderator variable Digital Transformation (DT), the standardized coefficient of the CSR*DT interaction cluster is -0.066, showing that digital transformation has a negative regulatory effect on the relationship between CSR Implementation (CSR) and Firm Performance (FP). This is a new finding of the authors, showing that the impact of CSR on FP is still unstable and can be affected by other factors.

To explain, SMEs with a high level of digital transformation tend to focus on applying digital technology to optimize processes and improve performance can bring positive firm performance faster, leading to faster operations, hence CSR activities become less important. In businesses with a low level of digital transformation, implementing CSR can be seen as an opportunity to create a difference and stand out in a competitive market. When the resources and competitiveness of small and medium-sized enterprises are limited, implementing CSR can be a way to build trust and loyalty from customers and the community, thereby producing good performance.

In addition, when analyzing the impact of the moderator variable, the authors also consider a direct relationship from the moderator variable DT to the dependent variable FP. The result for the standardized coefficient is 0.265, showing that there is a positive impact between DT and FP.

In summary, based on the above analysis, the research results indicate that all hypotheses from H1 to H8 are accepted.

5. Discussion and Conclusion

The research focuses on clarifying the direct relationship between CSR implementation and financial performance in a model with multiple mediating and moderating variables. The analytical results show a positively correlated relationship, similar with the findings of Torugsa et al. (2011), some studies provided in the literature review. In Vietnam, out of around 13,000 national standards developed, over 750 standards are aimed at promoting green growth, with the majority of environmental and social standards being mandatory. The government's efforts to lead Vietnam towards a sustainable development country and economy have compelled businesses to proactively research, adapt, and adjust operations to meet market demands. In reality, a successful business is now evaluated not only by economic indicators but also by community benefits and contributions to the environment and society. Carrying out social responsibilities is becoming essential and can directly impact the efficiency of business operations.

The group of authors also found that the higher the digital transformation level, the weaker the relationship between implementing CSR and financial performance effectiveness, and vice versa. This result provides a new perspective and additional information related to the field of research on CSR and digital transformation. A better understanding of the relationship between implementing CSR and the effectiveness of financial performance under the moderating of digital transformation can help the Government and corporate managers develop appropriate supportive strategies and policies, ensuring that business activities not only optimize profits but also positively contribute to the country's sustainable development goals. At the same time, the authors also encourage further research to delve deeper into this interaction to provide more detailed and multidimensional insights.

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The Relationship between Social Responsibility, Business Benefits, and Financial Performance of Tourism Enterprises in Vietnam

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Abstract

Tourism is a comprehensive economic sector that is increasingly important for socio-economic development. Tourism development will contribute to economic restructuring, bring in national budget revenue, attract investment capital and export goods on the spot, and have a positive impact on the development of related economic sectors. Tourism also contributes to implementing the policy of hunger eradication and poverty reduction, creating many jobs, and bringing regular income to workers in many different regions. From a social perspective, tourism is an activity to serves people's needs for rest, entertainment, and study. This is a widespread need, the higher the standard of living, the greater the need for tourism. For Vietnam, tourism is considered one of the three key economic sectors, focused on investment, constantly developing, and making positive contributions to the national economy. The tourism industry in Vietnam has been creating employment opportunities, reducing poverty, and promoting economic growth. In recent years, sustainable development has become the vision and mission of most countries. Therefore, sustainable development goals and corporate social responsibility concepts guide most organizations' business activities. This study aims to examine the relationship between corporate social responsibility (CSR) and business benefits and financial performance of tourism enterprises and their overall impact on achieving sustainable tourism in Vietnam. The results of the study show that increasing the implementation of social responsibility has a strong and positive impact on the increase in business benefits, while the increase in business benefits has a strong and positive impact on the financial performance of enterprises. The study contributes a theoretical model on the relationship between social responsibility, business benefits, and financial performance for further studies.

Keywords: *Corporate social responsibility, corporate financial performance, tourism business*

1. Introduction

For each country, tourism development will contribute to economic restructuring, bring in national budget revenue, attract investment capital and export goods on the spot, and have a positive impact on the development of related economic sectors. In addition, tourism development also contributes to implementing poverty reduction policies, creating many jobs, and bringing regular income to workers in many different regions. From a social perspective, tourism is an activity to serves people's needs for rest, entertainment, and study. This is a widespread need, the higher the standard of living, the greater the need for tourism. For Vietnam, tourism is considered one of the three key economic sectors, focused on investment, constantly developing, and making positive contributions to the national economy. The tourism industry in Vietnam has been creating job opportunities, reducing poverty, and promoting economic growth. Sustainable development has become the vision and mission of most countries. In the current new context, corporate social responsibility (CSR) is a tool to support tourism businesses to improve their competitiveness through increased operational efficiency and Financial performance, aiming towards sustainable development. According to the Global Compact Network Vietnam (GCNV, 2010), CSR contributes to increasing business value through social reputation, attracting, motivating, and retaining employees, attracting and creating consumer loyalty, and improving relations with investors and the financial community, with the government and local communities. However, many studies in the world on this issue show different results: many studies conclude that there is a positive relationship between CSR and corporate financial performance (CFP), while others argue that there is a negative relationship or no relationship between CSR and CFP (McWilliams & Siegel, 2000). The lack of consensus points to the need for further research on the relationship between CSR, business benefits, and financial performance. This study was conducted to determine the relationship between corporate social responsibility implementation and the financial performance of Vietnamese tourism enterprises.

2. Literature review and Hypothesis development

According to Carroll (1991), CSR includes the economic, legal, ethical, and charitable expectations of society for organizations at a certain point in time". From this definition, the balance of interests of stakeholders is set out as an internal relation with specific interests at different levels for the economic, legal, ethical, and charitable responsibilities of the enterprise (Cung & Duc, 2009). According to Freeman (1984), stakeholders are groups of people who have rights or demands for the enterprise. Specifically, they include suppliers, customers, employees, shareholders, local communities, and managers as representatives of these groups. This study limits the main stakeholders who are oriented in CSR practices to include: employees, customers, suppliers, communities, and the environment.

Regarding the relationship between CSR and performance, Fombrun et al. (2000) argued that there cannot be a simple relationship between CSR and performance because CSR affects profits through intermediary pathways, which are business benefits influenced by CSR. These benefits include enhanced reputation, increased sales and customer loyalty, increased ability to attract, motivate, and retain employees, and increased access to capital (Sweeney, 2009). These are also the direct business benefits of CSR mentioned in the study.

The author proposes hypotheses as follows.

H1: Increasing CSR implementation has a positive impact on increasing the business benefits of enterprises.

H2: Increasing business benefits (BB) has a positive impact on increasing the financial performance (CFP) of enterprises.

The research model is built based on summarizing theories and previous studies on the impact of CSR implementation.

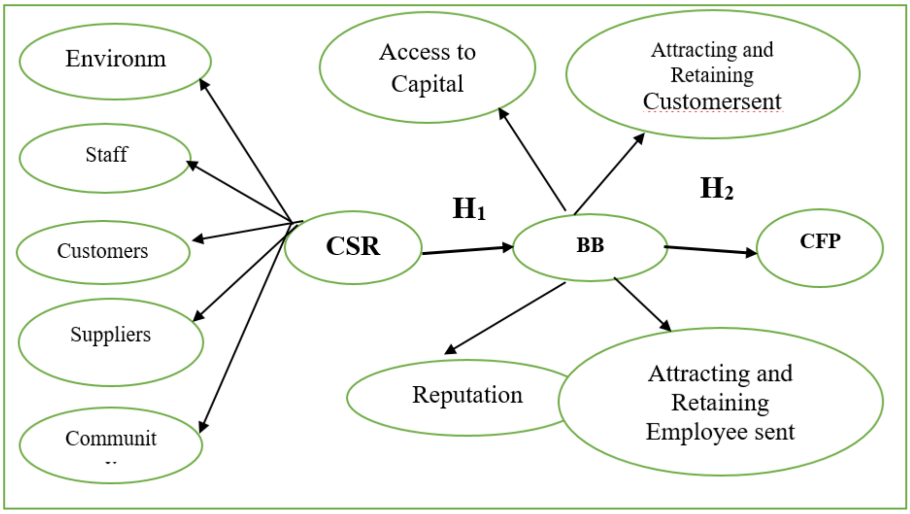


Figure 1: Theoretical model of the relationship between CSR and CFP of tourism businesses in Vietnam

Source: Author's synthesis

3. Methods

3.1. Data collection

According to Hair et al. (2006), to use EFA, the minimum sample size must be 50, preferably 100. The observation/measurement variable ratio should be 5:1. Trong & Ngoc (2008) also suggested that the sample size should be at least 4-5 times the number of observed variables, so with 16 initial measurement variables of the CSR scale, 15 measurement variables of the BB scale, to conduct EFA, the minimum sample size must be 16x4 = 64 observations). Due to limitations in time, cost, and difficulty in accessing businesses, the study accepted a minimum sample size of 64. The questionnaire for this study uses a 5-point Likert scale to measure the increase in CSR implementation and the increase in business benefits and operating efficiency that businesses have achieved in the past 5 years (2019 - 2023). With 1- No increase, 2- Increase a little, 3- Increase quite a lot, 4- Increase a lot, 5- Increase a lot. The sample was conducted by interviewing businesses directly, distributing questionnaires to businesses, designing websites for businesses to answer online, and sending emails to businesses. However, the most successful possibility that the study collected was interviewing and sending questionnaires.

3.2. Data analysis

Firstly, Test the reliability of the scale using Cronbach's Alpha coefficient: observed variables with a total correlation coefficient of less than 0.3 will be removed from the model. The study assessed the convergence of observations using EFA exploratory factor analysis: KMO and Bartlett tests were used to test the correlation relationship between variables and the suitability of the factor analysis model. Scale testing using confirmatory factor analysis (CFA): CFA allows testing of how well-observed variables represent factors.

Secondly, using structural equation modeling (SEM): This method is used to test a structural model – a model that specifies the relationships between latent variables. This model has advantages over traditional methods such as multiple regression because it can account for measurement error. Furthermore, this method allows combining latent concepts with their measured variables and can consider independent or combined measurements with the theoretical model at the same time.

4. Results

4.1. Results of assessing the reliability of the scales with Cronbach Alpha coefficient

The level of increasing CSR implementation is measured by 16 observed variables reflecting the responsibility of the enterprise to the environment, employees, customers, suppliers, and community. In which, the variable MT2 - "*Reduce packaging*" has a correlation coefficient of the variable - total less than 0.3 so it is removed from the scale. The Cronbach's Alpha coefficient after removing the variable is 0.915, the remaining variables all meet the requirements, so the scale is accepted.

The remaining scales including the scale measuring the level of increasing business benefits (including 12 variables) and financial efficiency (including 3 variables) all meet the requirements with high Cronbach's Alpha coefficients showing that the measured variables are good (Thuan et al., 2012).

Table 1: Cronbach's Alpha coefficient of the scales

Scale	Variable mandarin close	Soy sauce variable – total	Alpha if type variable
CSR Alpha =0.915	MT 1 - Reduce minimum garbage waste and re-regime	0.485	0.913
	MT3 - Have measure France limit regime Umbrella infected environment	0.558	0.911
	MT4 - History use original of course object whether close good lip school	0.508	0.913
	NV1 - Play develops Technical power and a professional career long gives NV	0.624	0.909
	NV2 - Against stool special opposite to treat	0.651	0.908
	NV3 - Level wage so with level wage central jar belong to Area area terrible economy	0.589	0.910

Scale	Variable mandarin close	Soy sauce variable – total	Alpha if type variable
	KH1 - Next receive, prize decide KH complaint belong to KH satisfy worth quick	0.723	0.906
	KH2 - Guarantee tell matter quantity	0.690	0.907
	KH3 - Bow grant information believe clear clear, main body about product product, DV	0.708	0.906
	KH4 - Matter quantity pandemic service care squirrel KH	0.620	0.909
	NCC1 - Bar maths correct limit fit copper	0.657	0.908
	NCC2 - The main book buy row labor equal	0.666	0.908
	NCC3 - Love bridge special point Technically art, information believe clear clear with home bow grant	0.677	0.907
	CD1 - Donate and contribute to good	0.568	0.911
	CD2 - Design set up Mandarin system Good and bright white with main right land direction	0.547	0.912
BB Alpha =0.934	GBNV1 - DN easy collect suck NV new	0.778	0.926
	GBNV2 - NV attach bundle long with DN	0.746	0.928
	GBNV3 - NV comedy heart about labor job	0.732	0.928
	GBNV4 - Dynamic force Does the job belong to NV	0.677	0.930
	GBKH1 - Business collect	0.668	0.930
	GBKH2 - Easy hold foot KH presently in	0.742	0.928
	GBKH3 - Quantity Guest row central wall	0.736	0.928
	DT1- Likelihood that employees will recognize a company for doing well in CSR	0.665	0.930
	DT2- The likelihood that customers will recognize a company as doing well in CSR	0.765	0.926
	DT3- Likelihood that other companies in the same industry will recognize the company for good CSR implementation	0.735	0.930
	TCV1- Easily get capital from banks and other lending institutions	0,691	0.928
	TCV2 – Easily get capital from investors	0.66 6	0.9 31
CFP Alpha =0.808	HQTC1- ROS growth rate	0.723	0.673
	HQTC2- ROE growth	0.661	0.736
	HQTC3- ROA growth	0.593	0.804

Source: Analysis results from survey data

4.2. Exploratory factor analysis (EFA)

The method of extracting the coefficients used is principal axis factoring with Promax rotation for the CSR scale and the business benefit scale (Multidimensional concept) and the principal components method with varimax rotation will be used for the financial efficiency scale (Unidimensional concept).

EFA of the CSR implementation scale

The first EFA result extracted 3 groups of factors with a total extracted variance of 59.84% (>50%) meeting the requirements. However, the variable nv3 has a factor loading coefficient of 0.411, which is less than 0.6, so it was removed from the scale. The final EFA results are presented in Table 2. The variable KH3 - providing clear and accurate information about products and services is retained because in the research market, information sources from customers are increasingly important and it is completely reasonable for businesses to provide accurate information about products and services and should be mentioned in the study.

Table 2: EFA results of the CSR scale

Observation variable	Factor		
	1	2	3
KH4- Matter quantity pandemic service care squirrel KH	0.975		
KH1- Next receive, prize decide Complaint complaint belong to KH satisfy worth fast fast	0.790		
NV 1- Develop long-term skills and careers for workers	0.767		
NV 2- Anti-discrimination	0.656		
KH2- Guarantee tell quality	0.612		
KH3- Bow grant information believe clear clear, main body about product product, DV	0.539		
NCC2- The main book buy row labor equal		0.870	
CD1- Donate and contribute to good		0.814	
CD2- Design set up Mandarin system Good and bright white with main right land direction		0.744	
NCC1- Bar maths correct limit fit copper		0.658	
NCC3 – Require clear specifications and information from suppliers		0.654	
MT3- Have measured France's limit regime Umbrella infected lip school			0.918
MT1- Reduce minimum garbage waste and re-regime			0.738
MT4- History uses original of course object whether the close good environment			0.618

Source: Analysis results from survey data

Checking the conditions of EFA, we have KMO = 0.847 (>0.5 and <1) meeting the requirements and Pvalue = 0.00 < 0.05 showing that the variables are correlated with each other and the data is suitable for EFA. The EFA results extracted three factors with a total extracted variance of 61.23%, meaning that these three factors explain 61.23% of the variation in the data. Due to the disturbance of observed variables among the initial hypothesized factors, the three groups of factors after EFA were renamed: 1 - Organizational quality, 2 - Social relations, and 3 - Environmental protection. EFA of business benefits scale (BB).

The first EFA result extracted 2 factors with the total extracted variance reaching 61.753% (>50%) meeting the requirements. However, the variables dt3, dt1, and GBNV2 had factor loading coefficients <0.6 so they were successively eliminated from the scale. However, the study decided to retain the variable gbkh1 - business revenue, because the factor loading coefficient of this variable was close to 0.6, moreover, business revenue is an important factor when mentioning business benefits of the enterprise, on the other hand, this variable is very meaningful in CSR research. The EFA results after eliminating the above variables are presented in Table 3.

Table 3: EFA results of BB scale

Observation variable	Factor	
	1	2
GBKH2-Retain existing customers	0.849	
GBKH 3-Loyal customer base of the enterprise	0.844	
GBNV3-NV satisfied with the work	0.843	
GBNV 4-Employee motivation	0.714	
DT2-The likelihood that customers will recognize businesses that perform well in CSR	0.653	
GBKH 1-Business revenue	0.589	

Observation variable	Factor	
	1	2
TCV2 – Easy to get investment capital		0.911
TCV1 – Easily get capital from banks and lending institutions		0.805
GBNV1-Attracting new employees		0.715

Source: Analysis results from survey data

With the KMO value of KMO and Bartlett test being 0.872 (>0.5 and <1) and Pvalue = 0.00 (<α = 5%), the variables in the scale are correlated with each other and the model is suitable for factor analysis. The results extracted 2 factors from the remaining 9 observed variables with a total extracted variance of 64.69%. The factors were renamed as 1 - Organizational commitment, and 2 - Resource attraction.

EFA of the performance measurement scale (CFP)

The KMO value = 0.690 (>0.5 and <1) and Pvalue = 0.00 (<5%) shows that the observed variables are correlated with each other, so EFA is the appropriate method used to group the data. The EFA results extracted 1 factor with a total extracted variance of 72.56% (>50%) meeting the requirements.

Table 4: EFA results of the CFP scale

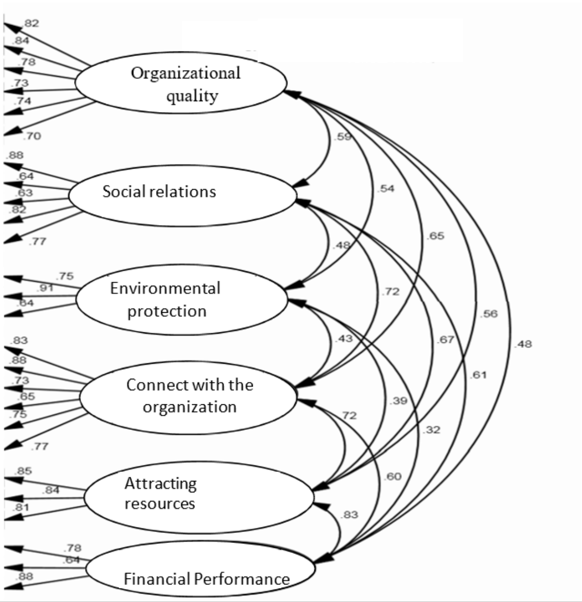
Observation variable	Factor
HQTC2 - ROE growth	0.889
HQTC3 - ROA growth	0.858
HQTC1 - ROS growth rate	0.807

Source: Analysis results from survey data

4.3. Confirmatory factor analysis (CFA) of the scales

To test whether the above measurement model meets the requirements and whether the scales meet the requirements of a good scale, the study uses confirmatory factor analysis (CFA). The Chi-square test of the critical model has a Pvalue = 0.001 <0.05. However, the Chi-square/df = 1.300 (<2), the TLI = 0.908 and CFI = 0.921 are all greater than 0.9, RMSEA = 0.070 <0.08. Thus, all the indicators meet the requirements, so the model is suitable for market data (Tho & Trang, 2008). Because the errors of the observed variables are correlated with each other, only the environmental protection, attraction, and financial efficiency scales achieve unidimensionality. The unstandardized weights are all statistically significant (P-value < 0.05) and the standardized weights are all > 0.5, so the scale achieves convergent validity (Gerbring & Anderson, 1988). In addition, the test results show that the P- P-values are all < 0.05 (Table 5), so the correlation coefficient of each pair of concepts is < 1 at 95% confidence level, so the concepts achieve discriminant validity.

Regarding the reliability of the scales, Table 6 shows that the Cronbach's Alpha coefficient (> 0.7), the composite reliability, and the extracted variance of the scales (≥ 0.5) all meet the requirements, so the scales are assessed as meeting the requirements.



$\chi^2_{[280]}$=363,906 (p=0.001); CMIN/df=1,300; TLI=0,909; CFI=0,921; RMSEA=0,069

Figure 2: Critical model measuring concepts in the standardized model

Source: SEM analysis results

Table 5: Results of testing correlation coefficients between concepts

Termites mandarin system			Wish	SE	CR	Pvalue
Matter quantity nest function	<-- >	Mandarin system commune festival	0.589	0.103	4,005	0.000
Matter quantity nest function	<-- >	Tell guard environment	0.539	0.107	4,310	0.000
Matter quantity nest function	<-- >	Attach conclude with nest function	0.649	0.097	3,633	0.001
Matter quantity nest function	<-- >	Collect suck source force	0.559	0.105	4,188	0.000
Matter quantity nest function	<-- >	Effect fruit finance	0.481	0.111	4,661	0.000
Mandarin system commune festival	<-- >	Tell guard environment	0.482	0.111	4,655	0.000
Mandarin system commune festival	<-- >	Attach conclusion with the team function	0.723	0.088	3,157	0.002
Mandarin system commune festival	<-- >	Collect suck source force	0.668	0.095	3,513	0.001
Mandarin system commune festival	<-- >	Effect fruit finance	0.607	0.101	3,894	0.000
BVmoitruong	<-- >	Attach conclude with nest function	0.435	0.114	4,941	0.000

Termites mandarin system			Wish	SE	CR	Pvalue
Environmental protection	<-- >	Collect suck source force	0.387	0.117	5,235	0.000
Environmental protection	<-- >	Effect fruit finance	0.318	0.120	5,664	0.000
Attach conclude with nest function.	<-- >	Collect suck source force	0.720	0.088	3,177	0.002
Attach conclude with nest function.	<-- >	Effect fruit finance	0.597	0.102	3,955	0.000
Collect suck source force.	<-- >	Effect fruit finance	0.832	0.070	2,384	0.020

Source: Analysis results from survey data

Regarding the reliability of the scales, Table 6 shows that the Cronbach's Alpha coefficient (> 0.7), the composite reliability, and the extracted variance of the scales (≥ 0.5) all meet the requirements, so the scales are assessed as meeting the requirements.

Table 6: Summary of reliability test results of the CSR scale

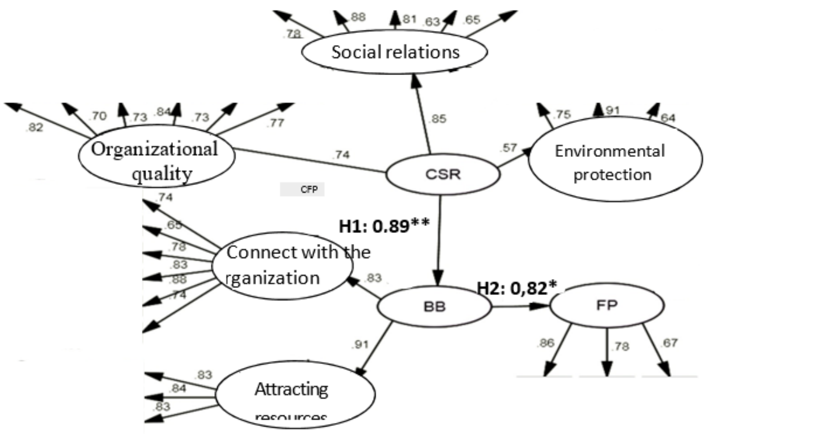
	Ingredient	Number of variables	Reliability		Extracted variance	Value
			Cronbach's Alpha	Total fit		
CSR	Matter quantity nest function	6	0.896	0.896	0.590	Meet the requirements
	Mandarin system commune festival	5	0.873	0.867	0.570	
	Tell guard lip school	3	0.798	0.816	0.601	
BB	Attach conclude with nest function	6	0.903	0.898	0.598	
	Collect suck source force	3	0.872	0.873	0.696	
CFP		3	0.808	0.814	0.598	

Source: Analysis results from survey data

4.4. Analysis of the relationship between CSR and CFP

Testing the theoretical model using SEM

The results of the structural model testing presented in Figure 2 show that the model has 288 degrees of freedom with Pvalue = 0.000 <0.05. However, other indices indicate that the model fits the market data (Chi-square/df = 1.307<2, TLI = 0.906 and CFI = 0.917>0.9, RMSEA = 0.07<0.08).



$\chi^2_{[288]}$=376,395 (*p*=0,000); CMIN/df=1,307;TLI=0,906;CFI=0,917; RMSEA=0,070; **p*<0,001; ***p*<0,01

Figure 3: SEM results of a theoretical model

Source: Compiled by the author from SEM analysis results

The unstandardized estimation results of the main parameters show that the two hypothesized relationships are statistically significant (Pvalue<0.05): CSR – BB (0.002) and BB – CFP (0.000). Furthermore, the standardized weights are all positive, indicating that CSR has a strong and positive impact on business benefits (the impact level is 0.893), and business benefits also have a strong and positive impact on operating efficiency (the impact level is 0.823). The explanatory power for the dependent variables in the model is also quite high, specifically, BB is explained by 79.8% by CSR, and operating efficiency is explained by 67.7% by business benefits. The research model is different from the previous model because the CSR scale and the business benefits scale have different clustering distributions, which is due to the collected market data shown above. However, to explain this result is also quite appropriate that the research on the concept of social responsibility for the tourism industry is a relatively new concept, in other questions of the study that surveyed businesses about the understanding of businesses about CSR implementation, most businesses do not recognize what CSR is. However, in the activities of businesses, CSR activities have increased. Therefore, it can be argued that the implementation of CSR by tourism businesses in Vietnam is not arranged according to the theoretical scale of CSR and business benefits. This is also what the study needs to re-examine the scale of the research model by performing confirmatory factor analysis CFA.

Testing the reliability of the estimate using Bootstrap

This study uses the Bootstrap method with the number of replicate samples N = 300. The results show that the absolute value of CR is very small compared to 2, so it can be said that the bias is very small, and not statistically significant at the 95% confidence level. Thus, we can conclude that the estimates in the model can be reliable.

Table 7: Bootstrap estimation results

			ML Estimate	Bootstrap Estimation					
				SE	SE-SE	Mean	Bias	SE-Bias	CR
BB	<---	CSR	0,893	0,133	0,005	0,887	-0,006	0,008	-0,75
FP	<---	BB	0,823	0,085	0,003	0,818	-0,004	0,005	-0,8

Source: Author

5. Discussion

This study aims to examine the effectiveness of CSR implementation of tourism enterprises in Vietnam in recent times and propose solutions to overcome existing difficulties, showing many remarkable results. Regarding the components of CSR, the results show that the level of CSR implementation of tourism enterprises in Vietnam is measured through three components: "*Organizational quality*", "*Social relations*" and "*Environmental protection*". Business benefits affected by CSR include "*Organizational commitment*" and "*Resource attraction*". The research results also clarify the relationship between CSR and operational efficiency, increasing CSR has a strong impact on increasing business benefits of enterprises, thereby promoting increased operational efficiency as an indirect benefit from CSR. In terms of practice in Vietnam, the study shows the relationship between the implementation of corporate social responsibility and the operational efficiency of enterprises. The above model explains that the implementation of corporate social responsibility affects the commitment of the workforce to the organization, attracting internal and external resources - these are concepts that affect the financial performance of the enterprise. The relationship between the implementation of corporate social responsibility of tourism enterprises in Vietnam has an impact on the long-term performance of the enterprise through the impact on the commitment to the organization and attracting resources of the enterprise. The study shows a clearer view of tourism enterprises in implementing their social responsibility in the long term will increase the efficiency of the enterprise. Some solutions to promote the implementation of corporate social responsibility of tourism enterprises in the coming time.

Raising awareness of CSR implementation in tourism enterprises

The research results show that the understanding of CSR is still inadequate, raising leaders' awareness of CSR is currently an urgent issue. Therefore, enterprises need to create conditions for managers, leaders, or union officials to be trained and coached on the content and methods of implementing CSR through programs, seminars, and projects on CSR organized by universities, non-governmental organizations (such as professional associations, business associations, social enterprises, VCCI, Business Office for Sustainable Development, etc.) or government agencies (such as District People's Committees, cities, etc.). Only through training can managers at all levels grasp the basic knowledge of CSR, clearly understand the benefits of CSR to have the determination to implement CSR. In addition, businesses need to proactively access CSR guidance information from various sources such as mass media, mainly from the Internet. However, when accessing this source of information, businesses must analyze and select the correct and necessary information. Visiting and learning from the experiences of businesses that do well in CSR is also a practical and effective way. Businesses can also invite consultants to support information and guidance on implementation, etc. Among the conditions for implementing CSR in businesses, the commitment of leaders plays a decisive role, in other words, CSR must originate from leaders, because if leaders do not understand CSR, and do not proactively pioneer or support CSR activities, CSR practice cannot be successful. At the same time, implementing CSR must be based on building trust and support from customers and the public, all employees, suppliers and distributors, investors and banks, and government organizations, so business leaders need to voluntarily implement CSR with their hearts rather than just out of responsibility or PR form.

Furthermore, CSR should be implemented first and foremost within the business itself, CSR needs to be applied in all aspects of business operations and with all stakeholders, making CSR a part of the business culture. To achieve that, it is necessary to innovate corporate governance thinking, specifically: renewing the corporate philosophy - turning the corporate charter into a guarantee for more responsible corporate behavior, strengthening customer-oriented management, especially allowing two-way information and feedback from customers.

CSR needs to be included in the business development strategy based on the strengths, weaknesses, opportunities, and threats of the business itself so that CSR is closely linked to the business in the long-term orientation. From there, based on the balance of using limited resources, businesses choose CSR activities and areas that are closely linked to the business's production and business activities to achieve the best results for the business as well as society.

Strengthening CSR activities for stakeholders

Responding to customers and employees

For customers, businesses can immediately practice activities such as providing clear and accurate information about products and services to customers, increasing customers' access to goods and services through participating in trips to bring goods to rural areas, home delivery, etc. Activities such as improving the quality of goods and services, paying attention to the needs and satisfaction of consumers, enhancing customer care before, during, and after sales, etc. can be implemented step by step.

For employees, businesses need to learn and implement CSR according to employees' wishes, starting to implement CSR with activities such as not using child labor, accepting people with disabilities, applying disciplinary measures according to regulations, not discriminating among employees in terms of salary and benefits, being clear and transparent in calculating and paying salaries, assigning a person in charge of safety and health for employees, training employees on safety and health protection, ensuring that wages are not lower than the minimum, that working hours and breaks for employees comply with the law, and taking care of workers' meals. At the same time, businesses also need to give employees the right to proactively implement CRS, that is, to let employees propose and organize CSR programs so that they see that they are truly an important part of the business. As for activities such as investing in improving working conditions, and working environment, reducing toxicity and heat, and investing in new machinery and equipment to avoid harming workers, the evaluation system, employee training, and salary and bonus system are reasonably designed based on stimulating employees' motivation to work, ensuring a living wage for workers, paying social insurance and health insurance for them, and paying attention to improving the quality of spiritual life for workers (through trade union activities, tourism, sports, arts, etc.).

Responding to suppliers and the community through establishing social relations

For suppliers, businesses can immediately practice some activities such as providing accurate and clear technical specifications for goods and services to suppliers, implementing good communication with suppliers, etc. In addition, the following activities also need to be considered by businesses to pay on time according to the contract by investigating the demand before organizing production, and reasonable inventory to avoid capital stagnation, thereby limiting the extension of debts with suppliers. Moreover, businesses can also provide capital, science, and technology support for production, packaging, and preservation, for suppliers, contributing to improving the quality of raw materials.

For the community, in addition to contributing to community support funds, businesses can also participate in vocational training for local workers, etc. However, the way of doing social work in Can Tho is generally not professional, so sometimes the money spent can bring great social meaning but becomes a waste. Usually, businesses do not have a specialized social work department, so cooperation with specialized and professional non-governmental/non-profit organizations is necessary to make their contributions to society most effective. In addition, businesses also need to find financial partners to help share the financial burden of community benefit programs while still ensuring effectiveness. With the scale of businesses being mainly small and medium, a proposed type of cooperation is "percentage clubs", businesses that use 1% (or more) of their profits for social work. Using this ratio helps avoid comparing the contributions of enterprises, more suitable for the size and situation of each enterprise. In addition, in the context of economic difficulties, enterprises can also seek support from the government in terms of policy and implementation support for issues that receive much attention from the government and stakeholders. To implement effective programs, enterprises should focus on the ability to influence and selectively solve the most important social problems.

Environmental protection

Tourism businesses can immediately practice CSR activities such as monitoring energy and water usage, establishing a database, and monitoring to adjust operations to save energy and water consumption during business operations. Specifically, limiting the use of air conditioning from 8 am to 9:30 am when the outside temperature is not hot to save electricity; using single-sided paper in the business, requiring employees to turn off lights, fans and electrical equipment and machines after use and reusable bags, limiting the use of plastic bags, collecting materials (paper, used water, packaging, etc.) and finding suitable reuse solutions; posting posters and signs to remind and encourage employees to follow; providing customers with necessary information about product specifications and how to handle waste after use; having a plan to maintain and service machinery periodically to save energy during production operations.

In the long term, businesses need to research and study the possibilities of investing in applying or improving energy-saving technologies and green solutions. Specifically, businesses can research and apply technologies using renewable energy sources such as solar energy, wind power, and biogas in some of the company's activities, research and proceed to replace or install energy-saving equipment, for example, using compact lamps instead of fluorescent lamps for lighting, planning to gradually replace old equipment with new environmentally friendly and energy-saving technology, research and apply to replace toxic chemicals in the production process or materials containing chemicals.

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Uncertainty Spillovers and Vietnam's Stock Market Performance

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Abstract

As financial markets become increasingly interconnected, domestic economies, including Vietnam's, are exposed to heightened external uncertainty. Given Vietnam's rapid growth and trade openness, its stock market is particularly vulnerable to shocks, especially those originating from the US. To assess the impact of external uncertainty and promote financial stability, we employed ARDL modeling to analyze 246 monthly observations of VN-Index returns over a two-decade period from 2004 to 2024. Our findings reveal significant short-run effects of monetary policy, climate policy, and oil price fluctuations on the VN-Index. Notably, climate policy uncertainty has a positive impact on the stock market, suggesting a potential shift in investor sentiment towards greener investments. To mitigate the negative impacts of these factors, we propose several policy recommendations. These include reducing reliance on oil through investment in advanced technology, enhancing monetary policy communication, and promoting transparency while maintaining robust control. By implementing these measures, Vietnam can strengthen its stock market's resilience and foster sustainable economic growth.

Keywords: *ARDL model, climate policy uncertainty, oil price uncertainty, policy uncertainty, Vn-Index*

1. Introduction

The last few decades have seen a significant increase in financial and real globalization across both developed and developing economies worldwide (Mensi et al., 2023). This global integration of financial markets has been further reinforced by the establishment of free trade areas and currency unions, facilitating the transmission of economic shocks from one country or region to another. While this interconnectedness offers numerous benefits, it also exposes domestic markets to increased vulnerabilities that can result in substantial economic consequences (He et al., 2014; Abaidoo & Ellis, 2016). As the advent of many crises, including financial, political, conflicts, and disease crises, has increased market uncertainty and made allocating funds more challenging (Mensi et al., 2023). They have the potential to disrupt the spillover structure and lead to unexpected fluctuations in the financial system, thus undermining public confidence and threatening financial stability (Billio et al., 2012). Vietnam, as one of the world's fastest-growing economies with substantial trade openness, may face increased susceptibility to external shocks in its stock market. The Vietnamese stock market, like others in the Asia-Pacific region, has shown strong dependence on the US economy since the 2008 global recession, making it vulnerable to US-originated shocks (Park, 2019; Dakhlaoui & Aloui, 2016). Consequently, examining the impact of external uncertainty on domestic stock markets is crucial for ensuring financial stability and attracting capital flows.

Among global uncertainty, climate change directly affects socioeconomic development activities across the globe, particularly in developing countries (Ali et al., 2016; Khan & Farooqui, 2021; Subroto & Datta, 2023). Given this intricate landscape, countries must continually update and adapt their policies to effectively respond to unforeseen disruptions and their far-reaching consequences. While numerous studies have explored the link between financial market volatility and external uncertainties such as monetary and trade policy uncertainty (Adeloye et al., 2024; Hu et al., 2023), there is a lack of comprehensive research on the relationship between climate policy uncertainty and stock markets in developing countries like Vietnam. By expanding the current discussion beyond traditional economic uncertainties, we aim to contribute a nuanced understanding of how policy uncertainties, including climate policy uncertainty, can influence Vietnam's stock market performance. By addressing this gap, this study aims to contribute to a more nuanced understanding of how policy uncertainties, including climate policy uncertainty and traditional economic indicators, affect Vietnam's stock market performance. Following this introduction, the rest of the paper is organized as follows. Section 1.2 presents a literature review and hypothesis development. Section 2 details the methodology employed and describes the data utilized in this study. Empirical findings are presented and discussed in section 3, followed by the concluding remarks and implications in section 4.

2. Literature review and Hypothesis development

The stock market is defined as a public entity where company stocks and derivatives are traded Gupta et al (2023). These securities can be listed on a stock exchange or traded privately. It acts as a virtual marketplace, enabling the trading of existing securities, and is a key indicator of the efficiency of capital movement and economic development. While financial globalization promotes growth and reduces poverty by efficiently allocating capital (Mishkin, 2009), global economic downturns and macroeconomic fundamentals significantly affect Vietnam's stock market risk (Vo & Nguyen, 2024). For intance, an unexpected change in the Federal Funds Rate, lead to negative stock returns, especially during periods of high uncertainty. Such uncertainty in monetary policy could heightened stock market volatility, adversely affecting overall market performance (Adeloye et al., 2024), specially in the developing countries (Ullah et al., 2024).

On the other hand, climate policy uncertainty can have complex and sometimes counterintuitive effects on different sectors of the economy. While it may create a more favorable environment for carbon-intensive companies due to the lack of clear regulations, potentially leading to increased emissions and higher share prices for these firms (Lavigne & Tankov, 2023), it can also have unexpected impacts on other assets. For instance, increased climate policy uncertainty has been associated with a decline in carbon emission allowance prices and a rise in ESG stock values, highlighting the intricate relationship between policy uncertainty and asset valuation (Iqbal et al., 2024). In Vietnam, climate policy uncertainty has been shown to promote green activities among firms. This includes increased green finance and innovation, as companies proactively adapt to potential regulatory changes by investing in sustainable practices (Hong et al., 2024).

Moreover, fluctuations in oil prices can influence stock market performance (Cui, 2023). The response to oil price volatility is heterogeneous across different countries. While importing countries often show a negative correlation with oil prices, exporting countries may benefit from rising oil prices, using them as a hedge or diversifier (Escribano, 2023). Although Vietnam has significant crude oil reserves, estimated at 4.4 billion barrels (IEA, 2022), the country still has to import about 70% of its total annual oil consumption because domestic production is not enough to meet demand (IEA,2023). Additionally, gold price has been a driving factor behind market volatility for centuries. The volatility of gold prices can have negative repercussions on stock market returns, it can create unsafe investment conditions, which in turn disrupts both hedging decisions and derivative valuations in financial markets (Tiwari et al., 2019). While some studies, suggest a positive correlation between gold prices and stock market returns in certain contexts, this relationship can be negative in other emerging markets (Shabbir & Batool, 2020).

Furthermore, it offers theoretical and empirical support for the idea that firm-level investment decisions in international trade might be influenced by trade policy uncertainty (Chen, 2023). Since exporters must decide whether to enter a market, they are vulnerable to uncertainty in foreign trade policy, which lowers the value of export enterprises (Handley & Limão, 2015), which may indirectly affect stock market performance (Akdağ et al., 2021).

Based on existing studies, the authors propose following hypotheses:

Hypothesis	Explain	Source
H1	Increased uncertainty in monetary policy is negatively correlated with the Vn-Index (VNI)	Adeloye et al. (2024)
H2	Increased uncertainty in climate policy is positively correlated with the Vn-Index (VNI)	Hong et al. (2024)
H3	Fluctuations in oil prices are negatively correlated with the Vn-Index (VNI)	Oboh et al. (2023)
H4	Fluctuations in gold prices are negatively correlated with the Vn-Index (VNI)	Shabbir & Batool, (2020)
H5	Increased uncertainty in trade policy is negatively correlated with the Vn-Index (VNI)	Akdağ et al., 2021

3. Methods

3.1. Data

The study uses monthly time series data of Vietnam's stock market indicate to estimate the market return over the period of 2004 to 2024 (20 years). Moreover, a set of uncertainty variables are also employed, including (1) the monetary policy uncertainty index (MPU), (2) the climate policy uncertainty index (CPU), (3) oil prices uncertainty index (OPU), (4) gold price (GP) and (5) the trade policy uncertainty index (TPU). These variables and their data sources are described in the Table 1.

Table 1: Description of variables

Variables	Description	Source
Stock market indice	Vnindex (VNI)	Investing.com
Uncertainty measures	Monetary policy uncertainty index (MPU)	Policyuncertainty.com
	Climate policy uncertainty index (CPU)	Policyuncertainty.com
	Oil price uncertainty index (OPU)	Policyuncertainty.com
	Gold price (GP)	London bullion market (LBMA)
	Trade policy uncertainty index (TPU)	Policyuncertainty.com

Source: Compiled by the author

3.2. Methodology

The Augmented Dickey-Fuller (ADF) test examines the stationarity properties of all the time series variables. To investigate the short-run and long-run relationships between uncertainty and the Vietnamese stock market, this study applies the Autoregressive Distributed Lag (ARDL) approach. Specifically, the Long Run Form and Bound test check the long-run relationship, while the Error Correction Form examines the short-run relationship among the variables. Then, the LM test and Heteroscedasticity Tests examine the residual diagnostics.

In our study, global economic and policy uncertainties such as monetary policy (MPU), climate policy (CPU), oil price (OPU), gold price (GP), and trade policy (TPU) affect the VN-Index (VNI). Therefore, the specific model is illustrated in the equation below:

$$VNI_t = \beta_0 - \beta_1 MPU_0 + \beta_2 CPU_t - \beta_3 OPU_t - \beta_4 GP_t - \beta_5 TPU_t + \mu_t$$

Where, μ_t is the random error term; β_0 is the constant term; $\beta_1, \beta_2, \beta_3, \beta_4$ and β_5 are the coefficients.

3.2.1. Stationarity test

The study employed the Augmented Dickey-Fuller (ADF) test to test for the existence of a unit root in the model. The generalized form of the ADF is stated as:

$$\Delta Y_t = \alpha V_t + \pi Y_{t-1} + \sum_{i=1}^{n} d_i \Delta Y_{t-i} + \omega_t$$

Where, Y_{t-1} is the differenced past values of the process, α is the estimated parameter, V_t contains deterministic terms, Δ is the first difference operator, ω_t is white noise term. The null hypothesis of ADF test is:

$H_0: \pi = 1$ (non stationary)

$H_0: \pi < 1$ (stationary)

3.2.2. Cointegrated test

To test if the model exhibits a long-run relationship, this study applies the Autoregressive Distributed Lag (ARDL) bound test approach to examine cointegration among the variables. Pesaran et al. (2001) constructed critical values based on the number of independent variables, with or without trend and constant terms. The critical values of the bounds test at the 95% confidence interval have both lower and upper bounds. If the F-statistic is lower than the lower bound critical value, then we fail to reject the null hypothesis, implying that there is no cointegration. Conversely, if the F-statistic exceeds the upper bound critical value, then we reject the null hypothesis, implying that cointegration exists. Furthermore, if the F-statistic falls between the lower and upper bound critical values, the result is inconclusive.

A hypothesis test is then with the following hypothesis:

$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6$

$H_0: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6$

3.2.3. ARDL model

Pesaran et al. (2001) highlighted the advantages of using the Autoregressive Distributed Lag (ARDL) approach when the variables are integrated of order one, I(1), or order zero, I(0), or a combination of both, but not of a higher order. Furthermore, Pesaran and Pesaran (1997) emphasized that the ARDL model specification should be conducted after performing the bounds test to determine the presence or absence of cointegration. This test guides researchers in determining the appropriate model specification for the study. Based on the ARDL model specification by Pesaran et al. (2001), following ARDL model can be illutrated in the equation below:

$$\begin{aligned}\Delta VNI_t = {} & \beta_0 + \alpha_1 VNI_{t-1} + \alpha_2 MPU_{t-1} + \alpha_3 CPU_{t-1} + \alpha_3 OPU_{t-1} + \alpha_4 GP_{t-1} + \alpha_5 TPU_{t-1} \\ & + \sum_{i=1}^{p} \gamma_1 \Delta VNI_{t-i} + \sum_{i=1}^{q_1} \gamma_2 \Delta MPU_{t-i} + \sum_{i=1}^{q_2} \gamma_3 \Delta CPU_{t-i} + \sum_{i=1}^{q_3} \gamma_3 \Delta OPU_{t-i} \\ & + \sum_{i=1}^{q_4} \gamma_4 \Delta GP_{t-i} + \sum_{i=1}^{q_5} \gamma_5 \Delta TPU_{t-i} + \mu_t\end{aligned}$$

The ARDL model shows that the dependent variable is a function of the lag of the dependent and independent variables in the short and long run. The model is written in the form ARDL $(p, q_1, q_2, q_3, q_4, q_5)$, where p refer to the optimal lag order of the dependent variables and the q represent the optimal lag order for the regressor in the model, β_0 is the constant term, $\alpha_1, \dots, \alpha_5$ refer to the long-run parameters, the coefficient $\gamma_1, \dots, \gamma_5$ denotes the short-run parameters and μ_t represent the error term.

4. Results

4.1. Descriptive statistics

The Table 2 shows the large standard deviations for all variables suggest significant variability over the period studied. In particular, the Vietnam stock index (VNI), reflecting the volatility in financial markets. Similarly, the various policy uncertainty measures (MPU, CPU, OPU, TPU and the GP) exhibit substantial variability, indicating unstable or unpredictable price and policy environments.

Table 2: Descriptive Statistics

	VNI	MPU	CPU	OPU	GP	TPU
Mean	707.46	131.85	131.15	123.03	1412.17	51.87
Maximum	1498.28	407	411.9	367.73	2454.6	266
Minimum	214.32	26	28.16	18.29	394.8	11.3
Std.Dev.	332.99	74.49	68.22	70.95	488.03	45.72
Observations	246	246	246	246	246	246

Source: Compiled by the authors

4.2. Stationary test

The unit root Augmented Dickey-Fuller (ADF) test in Table 3 reveals that VNI and GP are stationary at first difference (they are integrated of order 1). The remaining variables are stationary at level (integrated of order 0). Thus, the variables are integrated of orders I(0) and I(1).

Table 3: Unit root test

Variables	At Levels	At 1^{st} Difference	Remarks I(d)
VNI	-2.216	-12.758^{***}	I(1)
MPU	-8.400^{***}		I(0)
CPU	-9.571^{***}		I(0)
OPU	-8.045^{***}		I(0)
GP	-3.108	-16.732^{***}	I(1)
TPU	-4.443		I(0)

Note: $*\,p < 0.1$; $**\,p < 0.05$; $***\,p < 0.01$

Source: Author's Estimation

4.3. Model estimation with the bound test

The study using the Pesaran et al (2001) criterion for the bound test to examined if the model exists a long-run relationship.

Table 4: Bound test for cointegration relationship

F-statistics	Level of Significance	Lower Bound	Upper Bound
2.454	5%	2.654	3.835

Source: Author's Estimation

The F-statistic value (2.454) does not exceed the bound criterion of 3.835 at a significance level of 5%, indicating that there is no evidence of cointegration in the study. As a result, the model does not exhibit long-run cointegration.

4.4. ARDL short-run estimates

Since there is no long-run relationship between the variables, the study examines the significance of short-run estimation in Table 5.

Table 5: ARDL short-run estimates

ARDL(2, 0, 0, 2, 0, 1) automatically selected based on the AIC				
Dependent Variable: ΔVNI_t(Vnindex)				
Regressor	Coeffiecient	Std. Error	T-stat	Prob.
D(VNI(-1))	1.159	0.062	18.43	0.000
D(VNI(-2))	-0.200	0.063	-3.14	0.002
MPU	-0.105	0.062	-1.69	0.093
CPU	0.197	0.080	2.45	0.015
D(OPU)	-0.032	0.068	-0.47	0.637
D(OPU(-1))	0.076	0.073	1.03	0.303

D(OPU(-2))	−0.135	0.066	−2.03	0.043
GP	0.006	0.010	0.60	0.547
D(TPU)	0.174	0.153	1.13	0.259
D(TPU(-1))	−0.222	0.152	−1.45	0.148
Cons	24.348	16.984	1.43	0.153
Durbin-Waston stat		1.941		
Breusch–Godfrey LM test		0.313		
White's test		0.053		
Ramsey Test		0.440		

Source: Author's Estimation

The results indicate that the Vietnam stock market index is primarily influenced by its own historical performance in the short term, with notable impacts from policy uncertainties such as climate policy uncertainty (CPU) and oil price uncertainty (OPU).

Climate policy uncertainty positively affects Vietnam's stock market at a 5% significance level. Specifically, a 1% increase in climate policy uncertainty is associated with a 0.197% rise in the VN-Index, supporting our hypothesis 2. This finding aligns with previous studies (Li et al., 2015; Hong et al., 2024). While this uncertainty may initially cause market fluctuations, it also enables more informed investment strategies, potentially leading to positive market adjustments over time. As CPU exhibits greater fluctuations, it incentivizes businesses to engage more extensively in green financial activities. This engagement allows companies to align their strategies with potential upcoming regulations, thereby reducing risks and securing a competitive advantage in the evolving market (Hong et al., 2024).

Moreover, fluctuations in oil price uncertainty (OPU) demonstrate a delayed but significant negative effect on the Vietnam stock market (VNI). This delayed response is evident in the second lag, where a 1% increase in oil price uncertainty leads to a 0.135% decrease in the VNI at the 5% significance level, thus supporting our hypothesis 3. This result is consistent with the previous study by Liu et al. (2022). As an emerging market, Vietnam is particularly sensitive to these changes due to direct impacts on energy-dependent sectors and indirect effects on investor sentiment and global demand.

On the other hand, gold prices (GP) in the short-run ARDL model show a positive but statistically insignificant effect (p-value = 0.547), indicating that fluctuations in gold prices do not have a meaningful impact on the Vietnam stock market index (VNI) in the short run. Therefore, our hypothesis 4 is not validated

Monetary Policy Uncertainty (MPU) exhibits a negative coefficient (-0.105) with a p-value of 0.093, indicating a potential adverse effect on the Vietnam stock market index (VNI) in the short run at 10% significance. This result aligns with previous studies (Adeloye et al., 2024; Karris et al., 2023) that demonstrate increased stock market volatility in response to monetary policy uncertainty, adversely affecting market performance over time. In contrast, Trade Policy Uncertainty (TPU) reveals statistically insignificant effects, both contemporaneously and lagged, with p-values of 0.259 and 0.148, respectively. This suggests that, in the short run, TPU does not play a crucial role in influencing the Vietnam stock market, leading to the rejection of our hypothesis 5.

Overall, the ARDL model performs well, with no significant violations of key assumptions. There is no evidence of serial correlation or omitted variable bias. While the White's test suggests marginal heteroskedasticity, it's not statistically significant at the 5% level.

5. Conclusion

This study examines the impact of uncertainty spillovers on Vietnam's stock market performance between 2004 and 2024. Using the ARDL model with 246 samples, we investigated both short-run and long-run effects. Our findings reveal significant short-run impacts of monetary policy, climate policy, and oil and gold price fluctuations on Vietnam's stock market performance, highlighting the sensitivity of emerging markets to external economic shocks and policy changes. Our study also contributes to the existing literature on emerging markets by providing new evidence regarding the positive relationship between climate policy uncertainty and stock market indices. Understanding this relationship is crucial, particularly for investors and policymakers navigating the transition to greener economies. To mitigate the negative impacts of these factors on the Vietnamese stock market and promote investment and economic development, we propose several policies.

The VN-Index indicates the current phase of the economy, whether it is expanding or contracting. An increase in the VN-Index indicates that firms are functioning efficiently, engaging in active investment and development, hence contributing to economic growth. Conversely, when the VN-Index declines, corporate performance deteriorates, indicating a recession, which significantly impacts investor sentiment and instills fear of divestment. Without capital, sustaining operations is unfeasible, leading to market downturns and economic deterioration. Consequently, based on the research findings, the authors recommend strategies to mitigate the adverse effects of factors on the VN-Index. Firstly, the study indicates that oil prices adversely affect the VN index. Vietnam is a nation that imports substantial quantities of oil; thus, the government must implement policies to diminish the economy's reliance on oil for production. The State should focus on investing in developing advanced technology, replacing outdated technology to reduce the consumption of petroleum resources and improve energy efficiency. Support funding for research projects, tax incentives for enterprises applying green technology, and encourage cooperation between universities, research institutes and enterprises in developing new technologies. In addition, it is necessary to invest in research and development of advanced oil refining technology. Vietnam is a major crude oil exporter, but still has to import a large amount of refined oil. In addition, it is necessary to promote training policies and improve skills for the workforce in high-tech fields, in order to create a high-quality human resource to serve the advanced technology industry. Secondly, intended to alleviate the adverse effects of MPU on the stock market. Requirement for Enhanced Predictability and Communication Increasing the predictability of monetary policy decisions can significantly reduce the exchange rate pass-through (ERPT) effects, as seen in Turkey. By stabilizing expectations, central banks can mitigate the impact of MPU on exchange rates, particularly during periods of leadership changes within central banks (Öbekcan et al., 2024). Effective communication by central banks, such as the Federal Reserve, can help neutralize the contractionary effects of policy rate increases. Clear communication reduces uncertainty, thereby stabilizing credit spreads and output (Husted et al., 2017). Moreover, Need to Balancing Transparency and Robust Control. While transparency is a cornerstone of modern monetary policy, excessive transparency can sometimes be counterproductive. It may lead to overemphasis on public signals by private agents, potentially destabilizing markets. Therefore, a balanced approach to transparency is recommended (Cao & Illing, 2019).

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Determinants Affecting to the America's Stock Market

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Abstract

This study explores the short-term effects of 294 samples of uncertainty factors impacting the U.S. stock market, finding that Economic Policy Uncertainty can have both positive and negative impacts, challenging the notion that uncertainty always harms market performance. Initial positive reactions to policy changes might stem from speculative trading, but sustained uncertainty can eventually hurt the market. Policymakers should carefully manage the timing and communication of policy changes to prevent long-term instability. The study also underscores the importance of including Equity Market Volatility in risk management, as it significantly influences market movements. Geopolitical Risk and Trade Policy Uncertainty showed minimal short-term effects, indicating domestic factors might be more crucial than global ones in the short term. Future research should focus on long-term effects, cross-country comparisons, and the impact of investor sentiment.

Keywords: *Economic policy uncertainty, equity market volatility, geopolitical risk, trade policy uncertainty, S&P 500.*

1. Introduction

Nowadays, due to globalization, national economies have enlarged in scale and become more intricately interconnected with the global economy. Globalization has intensified the interconnection of worldwide stock markets, generating investment opportunities but simultaneously heightening risks from global volatility. Ellen R. McGrattan and Edward C. Prescott (2001) assert that investors encounter both advantages and obstacles due to reliance on international economic trends. The US stock market is the preeminent worldwide financial hub, distinguished by liquidity, investor safeguards, and substantial market size. It serves as a trendsetter, impacting global stock exchanges, particularly via indices like the S&P 500 and Dow Jones.

Since 2010, the US stock market has experienced substantial growth. The average annual growth rate is 11.48% according to the S&P-500 stock index, indicating the dominance of the US stock market in growth rate relative to other countries (Morhachov et al., 2022). Nonetheless, this elevated growth rate is accompanied by concerns, including inflated market values and the potential for increased volatility in the future. Moreover, despite the US's leadership in growth, elements such as geopolitical conflicts, trade policies, and global economic volatility may influence the market's long-term stability. Consequently, investors must exercise caution and evaluate numerous factors while analyzing the potential of the US stock market within a global framework.

In recent years, extensive research has been conducted on factors influencing stock markets both generally and within specific economies (Caldara & Iacoviello, 2022; Yilmazkuday, 2024; Adeloye, 2024...). These studies have illuminated numerous determinants of market performance and have guided businesses in crafting strategies to enhance their market value. However, existing research often fails to provide a comprehensive analysis of all relevant factors or to explore cross-country data, focusing predominantly on macroeconomic variables within individual nations.

Therefore, our study investigates the U.S. stock market from 2000 to 2024, examining the effects of Geopolitical Risk, Economic Policy Uncertainty, Equity Market Volatility, and Trade Policy

Uncertainty. The results reveal that Economic Policy Uncertainty (EPU) can exert both positive and negative short-term effects, challenging the conventional belief that uncertainty invariably diminishes market performance. Initial positive responses to policy changes may be driven by speculative trading, but sustained uncertainty can ultimately harm the market. Effective timing and communication of policy adjustments are crucial for mitigating long-term volatility. Additionally, the study underscores the significance of integrating Equity Market Volatility (EMV) into risk management frameworks due to its substantial impact on market fluctuations. Conversely, Geopolitical Risk (GPR) and Trade Policy Uncertainty (TPU) demonstrate minimal short-term effects, suggesting that domestic factors may exert greater influence than global factors. These findings provide a foundational basis for both primary and advisory strategies aimed at stabilizing the stock market.

Our study investigates the U.S. stock market from 2000 to 2024 and aims to determine the effects of Geopolitical Risk, Economic Policy Uncertainty, Equity Market Volatility, and Trade Policy Uncertainty on the U.S. stock market. The results provide a foundational basis for both primary and advisory strategies aimed at stabilizing the stock market.

2. Literature review and Hypothesis development

2.1. S&P 500

The S&P 500 index, which was first launched in 1957, serves as a significant benchmark that accurately represents the performance of 500 prominent firms in the United States. It is widely regarded as a reliable indicator of the stock market's condition and the overall economic health of the country (Nzokem, 2024). The study of Goyanka (2024) utilizes machine learning algorithms to forecast and analyze the S&P 500 (SPY) index. This research highlights the index's potential for long-term investment and offers significant insights for decision-making in financial markets.

2.2. Geopolitical risk

Geopolitical risk is assessed via news-based indices, which negatively affect real activity, stock returns, and capital flows. It surges during significant historical events, influencing investments, disaster likelihoods, and diminishing risks at both the macroeconomic and corporate levels (Caldara & Iacoviello, 2022). Research indicates that an increase in global geopolitical risk results in statistically significant decreases in US equities values, particularly during periods associated with relevant events in the United States (Yilmazkuday, 2024). Simultaneously, heightened geopolitical risk is associated with diminished stock liquidity (Fiorillo et al., 2023). Based on the aforementioned findings, we propose the following hypothesis:

H1: An abrupt escalation in geopolitical concerns will result in a decrease in stock market investors.

2.3. Economic policy uncertainty

SA Al-Thaqeb (2019) found that economic policy uncertainty (EPU) has a substantial impact on business decisions, investment, and overall economic growth. EPU substantially influences various aspects of the financial markets in the United States. It affects the volatility of the stock market, the difference in interest rates between risky and risk-free assets (credit spreads), the yields of government bonds, and the volume of trading. These effects have implications for investment choices and overall economic stability (Adeloye, 2024). Based on this information, we propose the following hypothesis:

H2: Economic policy uncertainty amplifies fluctuations in financial markets and has a detrimental impact on investment choices and overall economic stability.

2.4. Equity market volatility

Stock market volatility is the fluctuation in stock prices due to factors such as inflation or interest rate changes, which affect bond returns, as observed in studies of G7 countries (Chen et al., 2023). The paper by Hitz et al. (2022) analyzes the pricing of volatility risk in the US stock market, emphasizing the importance of volatility in influencing market pricing and financial risk assessment. Chaudhuri and Smiles (2004) explored the relationship between stock index volatility and market sentiment, finding that economic shocks often lead to sudden declines in stock indices, followed by sharp increases in volatility. These movements are driven rapidly by the changes in investors' sentiment, as the new information spread. Likewise, Glosten et al. (1993) have also shown that equity market volatility tends to rise disproportionately during periods of stock market declines, implying an asymmetric relationship between stock returns and volatility. Based on the above observations, we hypothesize as follows:

H3: Stock market volatility plays an important role in pricing financial risks and affects the stock valuation process.

2.5. Trade policy uncertainty

Trade policy uncertainty (TPU) has become an influencing factor affecting the stock market performance, especially in the context of globalized economics. Research by Caldara et al. (2020) indicates that increased TPU leads to increased stock market volatility as investors steer away from the potential risks stemming from uncertain trade agreements and tariffs. This decrease in confidence prompts investors to demand higher risk premiums, which in turn contributes to greater fluctuations in stock prices, particularly in sectors heavily reliant on international trade. Pastor and Veronesi (2012) have also highlighted that TPU, not only increases stock market volatility but also affects equity valuations. Their study indicates that uncertainty about future trade policies raises the cost of capital for firms, leading to a dip in stock prices. This correlation is greatly emphasized in industries such as manufacturing, technology, and agriculture, where firms are more exposed to global trade and supply chains. Steinberg (2019) further highlighted that periods of heightened TPU, such as those during the U.S.-China trade conflict, saw a defining decline in stock prices for companies with significant exposure to international trade. U.S.- China trade conflict. Furthermore, studies similar to those of Liu and Zhang (2020) argue that the effects of TPU on the stock market are not limited to the period following the immediate announcement of trade policies but extend over time. Stock markets often remain volatile even after policy announcements, reflecting lingering investor concerns about long-term trade relations and economic stability.

H4: Trade policy uncertainty has a negative impact on investment choices and overall economic stability.

2.6. Theoretical framework

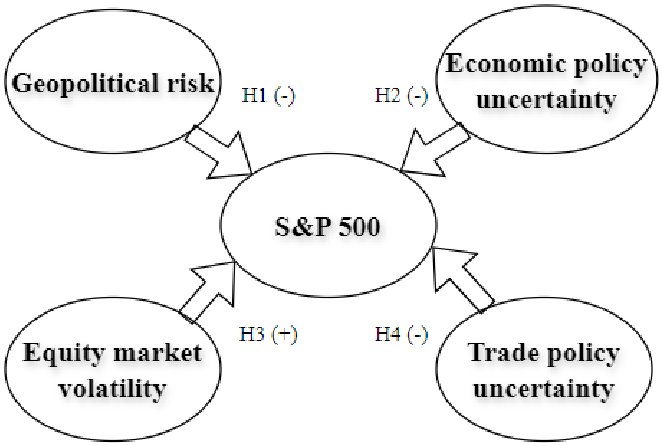

Figure 1: Theoretical framework

Source: Compiled by the authors

3. Methods

3.1. Data collection

We collected 294 samples about the 05 factors S&P 500 index, Geopolitical risk, Economic policy uncertainty, Trade policy uncertainty, and Equity market volatility from January 2000 to July 2024 to evaluate the influence of these determinants on the performance of the U.S. stock market.

3.2. Methodology

The study used Stata 17 software to analyze data through 02 steps:

(1) Assess the stationarity of the time series variables through The Augmented Dickey-Fuller (ADF).

(2) The Autoregressive Distributed Lag (ARDL) model was utilized to investigate both the short-term and long-term associations between the independent variables (geopolitical risk, economic policy instability, trade policy instability, equity market volatility) and the dependent variable (S&P 500). The Long-Run Form alongside the bound tests validated the presence of a long-term relationship, whereas the Error Correction Form was utilized to scrutinize the short-term dynamics.

3.2.1. Stationarity test (Unit Root Test)

In time series analysis, it is very important to use a stationary time series to avoid spurious causality. Spurious causality refers to a strong relationship between two non-stationary time series variables, while no causality exists between them. If the mean, variance, and autocovariance of a time series do not depend on time, then the series is known as stationary (i.e. no unit root). Otherwise, it is known as a non-stationary time series (i.e. unit root) (Gujarati, 2009). If the stationarity test shows a time series as stationary at level (without differencing, i.e., Yt), then the series will be integrated of order 0 or I (0). On the other hand, if the test shows a series as stationary at the first difference (i.e., Yt - Yt-1), then the series will be integrated of order 1 or I (1).

ADF test is based on the following regression equation:

- **Augmented Dickey-Fuller (ADF) Test:**

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \delta Y_{t-1} + \sum_{i=1}^{n} d_i Y_{t-i} + \mu_t$$

In this context, represents the differential of previous values of the process, the constant term is denoted as a constant, t signifies the temporal trend, the initial difference operator is indicated, n refers to the optimal number of lags, and the pure white noise term is represented accordingly. The null hypothesis of the ADF test posits that the time series is non-stationary.

3.2.2. Cointegration test

Cointegration tests identify situations where two or more non-stationary time series are integrated in a manner that prevents them from diverging from equilibrium in the long run. The tests evaluate the sensitivity of two variables to a consistent average price over a specified period. This serves as a prerequisite for evaluating the application of the ARDL. This research utilized the ARDL Bound test with critical values based on the study of Pesaran et al. (2001).

A hypothesis test is performed to ascertain the presence of a long-term relationship with the following hypotheses:

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$$

$$H_1: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq 0$$

The rejection of the null hypothesis indicates the presence of a long-term link or cointegration; conversely, failure to reject suggests the absence of cointegration among the variables.

3.2.3. The ARDL model

The ARDL (Autoregressive Distributed Lag) methodology is an adaptable technique for assessing short-run and long-run elasticities in small sample sizes, employing the ordinary least squares (OLS) method to investigate cointegration across variables (Duasa, 2007). It provides flexibility in the sequence of variable integration, rendering it appropriate for models with independent variables that are I(0), I(1), or mutually cointegrated (Frimpong & Oteng 2006). Nonetheless, ARDL is inapplicable when any variable is I(2). The method's versatility and efficacy in managing diverse integration orders render it a favored option for econometric analysis, especially in scenarios with constrained data availability or mixed integration orders among variables.

The standard model specification of the ARDL test is structured as follows:

$$lnSP500_t = \delta_0 + \alpha_1 GPR_{t-1} + \alpha_2 EPU_{t-1} + \alpha_3 TPU_{t-1} + \alpha_4 EMV_{t-1} + \alpha_1 \sum\nolimits_{i=1}^{p} \gamma_1 \Delta SP500_{t-i} + \sum\nolimits_{i=1}^{p} \gamma_2 \Delta GPR_{t-i} + \sum\nolimits_{i=1}^{p} \gamma_3 \Delta EPU_{t-i} + \sum\nolimits_{i=1}^{p} \gamma_3 \Delta TPU_{t-i} + \sum\nolimits_{i=1}^{p} \gamma_4 \Delta EMV_{t-i} + \mu_t$$

In this context, denotes the ideal lag order of the dependent variables, whereas the optimal lag order for the regressors in the model is represented by another variable. The constant term is indicated, and the long-run parameters are denoted by specific symbols. The coefficients reflect the short-run parameters, and the error term is also specified.

4. Results

4.1. Descriptive statistic

Table 1 shows the descriptive statistics for all variables. The descriptive statistics reveal significant variability across all variables. The S&P 500 index experienced wide fluctuations, with a mean of 2,049.57 and a standard deviation of 1,158.86. Geopolitical Risk (GPR) was relatively stable, though occasional spikes were evident. Economic Policy Uncertainty (EPU) and Trade Policy Uncertainty (TPU) demonstrated substantial variation, with TPU exhibiting the highest volatility. Equity Market Volatility (EMV) showed moderate fluctuations. These patterns underscore the broad variability in stock market performance and policy uncertainties during the observed period.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
S&P 500	295	2,049.57	1,158.86	757.13	5,553.15
GPR	295	2.96	1.15	1.12	10.85
EPU	295	124.13	44.04	57.20	350.46
TPU	295	126.23	71.97	41.00	541.00
EMV	295	20.91	8.15	9.57	69.83

Source: Calculated by the authors

4.2. Stationarity test (Unit Root Test)

We used the Dickey-Fuller test to check the stationarity of the time series data. The test results helped determine whether the variables were stationary or required differencing before proceeding with the analysis. This ensured that the data met the necessary conditions for accurate modeling.

Table 2: Stationary test

Variable	At level	At 1st Difference	Remarks
SP500	0.9939	0.0000	I(1)
GPR	0.0000		I(0)
EPU	0.0000		I(0)
TPU	0.0000		I(0)
EMV	0.0000		I(0)

Source: Calculated by the authors

The results show that GPR, EPU, TPU, and EMV are stationary at the level, they are integrated in 0. While the S&P500 is stationary at first difference. Hence, all the variables are integrated at I (0) and I (1).

4.3. Cointegration test

The Table 3 shows that F-statistic 4.004 is lower than the upper bound critical value 4.042 at a 5% significance level. Therefore, we can't reject the null hypothesis (no cointegration) and conclude that there isn't a long-run relationship among the variables. Since there isn't a long-run relationship among the variables, the study examines the significance of short-run coefficients and reports the estimated results in Table 3.

Table 3: Cointegration test

	90%		95%		99%	
F-statistics	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
4.004	2.458	3.536	2.885	4.042	3.805	5.110

Source: Calculated by Authors

4.4. The ARDL estimation

In this study, we applied the Autoregressive Distributed Lag (ARDL) model to examine the short-term dynamics of the variables. The findings, summarized in Table 4, offer valuable insights into the relationships between these variables.

Table 4: Short-run ARDL estimation

Variables	Coefficient	Std Err	P-Value
GPR	-0.6691104	3.581541	0.852
EPU			
L1	0.6236667	0.21783	0.005
L2	-0.4002636	0.2097922	0.057
L3	0.3385585	0.1799037	0.061
TPU	0.0153849	0.0565853	0.786
EMV			
L1	3.259548	0.7901541	0.000
_cons	20.24581	22.01186	0.358
Durbin–Watson		2.004	
Breusch–Godfrey LM test		0.833	
White's test		0.000	

Source: Calculated by the authors

The Durbin-Watson statistic (2.004) suggests no evidence of autocorrelation, and the Breusch-Godfrey LM test (0.833) further confirms that serial correlation is not present. However, White's test (p-value = 0.000) indicates potential heteroscedasticity, suggesting non-constant variance in the error terms.

Therefore, we employed Newey–West standard errors to address the Heteroscedasticity in the ARDL shor-run model in Table 4.

Table 5: Newey–West standard errors (with maximum lag = 2)

Variables	Coefficient	Newey-West std. err	P-Value
GPR			
D1	-4.426	5.002	0.377
EPU			
D1	-0.586	0.219	0.008
TPU			
D1	0.001	0.082	0.984
EMV			
D1	-3.808	1.155	0.001
_cons	14.084	4.821	0.004

Source: Calculated by Authors

Under the Newey-West adjusted errors, EPU and EMV exhibit significant short-run impacts on the dependent variable, while GPR and TPU remain statistically insignificant. The Geopolitical Risk (GPR) variable has a negative coefficient of -4.426, but it is not statistically significant with a p-value of 0.377, indicating that GPR does not have a significant short-term effect on the dependent variable. Therefore, our hypothesis 1 is not validated. Moreover, the Economic Policy Uncertainty (EPU) exhibits a positive and statistically significant effect, suggesting that an increase in EPU positively impacts the dependent variable in the short run. This supported our hypothesis 2.

The first difference of EMV (D1) has a significant impact SP500 index. However, the result showed a large negative coefficient (-3.808). Contrary to our hypothesis, this indicates that Equity Market Volatility (EMV) has a strong and significant negative effect in the short run. Therefore, our hypothesis 3 is not validated

The Trade Policy Uncertainty (TPU) variable, with a coefficient of 0.0153849 and a p-value of 0.786, does not show any meaningful impact on the dependent variable in the short run.

5. Discussion

The findings from the ARDL estimation shed light on the short-term dynamics of various uncertainty indices and market volatility in America's stock market. The initial hypotheses suggested that global and domestic uncertainties, as well as market volatility, would significantly impact stock market performance. The results largely align with these hypotheses, though some variables exhibit unexpected behavior.

Starting with Geopolitical Risk (GPR), the hypothesis assumed a negative impact on the stock market due to global instability. However, while the coefficient for GPR is negative, its high p-value suggests that global uncertainty does not exert a significant short-term effect on the stock market. This might indicate that the U.S. stock market is resilient to global policy shocks, possibly due to strong economic fundamentals or investors’ focus on domestic conditions in the short run.

In contrast, the Economic Policy Uncertainty (EPU) variable reveals more complex dynamics. The positive and statistically significant of EPU supports the hypothesis that rising economic policy uncertainty initially drives a positive reaction in the stock market, (Chowdhury et al.,2022). This counterintuitive result may be explained by short-term speculative behavior, where investors quickly adjust portfolios in anticipation of policy changes.

For Trade Policy Uncertainty (TPU), the hypothesis expected a negative effect due to fears of trade barriers and tariffs impacting corporate earnings. Yet, the TPU variable demonstrates an insignificant relationship with the stock market. This finding implies that trade-related uncertainties may not play a crucial role in influencing short-term market fluctuations, possibly because investors place more weight on other economic indicators or because trade policies are seen as longer-term concerns.

Contrary to expectations, Equity Market Volatility (EMV) demonstrates a robust and statistically significant negative correlation with stock market performance. The significance of this variable highlights how volatility, a reflection of investor sentiment and risk perception, directly influences stock market behavior. When market volatility spikes, it often triggers significant adjustments in stock prices, as uncertainty over future market conditions leads to increased trading activity (Khan & Hijazi, 2022). These fluctuations in investor sentiment can lead to corresponding changes in stock price volatility, with positive sentiment driving volatility upward and negative sentiment having the opposite effect (Guo, 2023).

6. Conclusion and Implications

The implications of this study provide important insights for both the academic community and practical stakeholders in understanding the short-term impacts of various uncertainties on the U.S. stock market. The finding that Economic Policy Uncertainty (EPU) exhibits negative short-term effects offers a better understanding of market behavior. This suggests that persistent uncertainty could eventually weigh on market outcomes. Policymakers, therefore, need to consider the timing and communication of economic policy changes, as prolonged or ambiguous policy directions could destabilize the market in the long run. Moreover, the significance of Equity Market Volatility (EMV) as a robust driver of stock market movements highlights the critical need for investors to incorporate volatility into their risk management frameworks. Active strategies that anticipate heightened volatility during uncertain times could mitigate potential losses and exploit short-term opportunities. Interestingly, the study shows that Geopolitical Risk (GPR) and Trade Policy Uncertainty (TPU) do not have significant short-run effects, indicating that the U.S. stock market may be more influenced by domestic factors than global or trade-related uncertainties in the short term. This has implications for investors who might overestimate the immediate impacts of global events on U.S. stocks. Lastly, this research opens several avenues for future exploration, including the long-term effects of these variables, cross-country comparisons, and deeper investigations into how market sentiment and investor psychology mediate the effects of uncertainty on stock market dynamics.

In conclusion, this study provides a comprehensive analysis of how various forms of uncertainty and volatility affect the U.S. stock market in the short term. These insights not only contribute to the broader understanding of stock market responses to uncertainty but also provide actionable recommendations for policymakers and investors. Future research could build upon these findings by exploring the long-term effects of these variables, investigating the role of investor sentiment, and expanding the analysis to include cross-market comparisons. Ultimately, this study underscores the importance of both policy stability and informed investment strategies in navigating the complex relationship between uncertainty and market performance.

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Climate Finance for Developing Countries: Policy Recommendations for Vietnam

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Abstract

Climate change is a matter of worldwide concern. In 2023, the world has witnessed a lot of severe consequences due to environmental pollution. To cope with the problems caused by climate change, countries around the world, especially developing countries, need large financial resources. However, developing countries have very limited resources. This problem shows the importance of climate finance from developed countries to developing countries. The article focuses on analyzing the challenges of mobilizing climate finance resources and the current status of the process of mobilizing and using climate finance resources for developing countries. Thereby, the article draws some policy implications for Vietnam in mobilizing and using climate finance resources effectively for the country's environmental issues.

Keywords: *Climate finance, developing countries, policy, Vietnam*

1. Introduction

Climate change has been and is increasingly becoming a global concern. The world is facing the increasingly serious effects of climate change. On July 27, 2023, United Nations (UN) Secretary-General Antonio Guterres called for urgent global action against climate change and stressed that climate change is present, causing serious impacts and this is just the beginning. "The era of global warming is over; The Earth is entering an era of boiling." The extreme impacts of climate change are consistent with forecasts and a series of warnings from scientists. However, the speed at which this phenomenon is happening is "astounding". In the face of this alarming reality, Secretary-General Guterres reiterated his call for swift and far-reaching action to address the devastating effects of climate change, including mobilizing sufficiently large financial resources and allocating them effectively so that the world can successfully confront the risks of climate change (Giglio et al, 2020).

This article will focus on analyzing trends in attracting financial resources to cope with climate change (referred to as climate finance) from developed countries to developing countries. On that basis, the paper offers some policy implications for Vietnam in attracting and using climate finance resources.

2. Methods

The data used in the article are secondary data sources collected from reports of reputable international organizations such as the Organisation for Economic Co-operation and Development (OECD) and the United Nations. This paper has modeled the data with tables and graphs to provide a visual view of the data related to the research problem and provide analyses and evaluations of the trends in change over time of the statistics.

The article combines a literature research methodology in which documents, reports, and articles that have been published abroad are analyzed to draw conclusions on analytical issues as well as serve as a basis for policy recommendations for the case of Vietnam.

3. Results

3.1. Climate finance: Context and challenges

3.1.1. Four priorities of climate finance

The United Nations Conference on Trade and Development (UNCTAD) outlined four priorities at an event entitled "Options for scaling up climate finance" co-hosted by German development agency GIZ and the Institute for Energy and Natural Resources at the Bonn Conference on June 6, 2023.

The first and most urgent priority is addressing the debt problem for developing countries: 60% of low-income countries are in or on the brink of debt and are spending an estimated five times more on debt repayment than on climate adaptation each year. This undermines resilience and upside prospects mature in the future. These countries need urgent debt relief. The long-term goal is to establish a multilateral debt settlement process to help low-income countries emerge from the vicious cycle of debt crisis and worsening climate problems (Arndt, 2015).

The second priority is to consider new ways to implement the IMF's Special Drawing Rights (SDRs) to maximize its role in climate issues. This may include transferring SDRs to multilateral development banks (MDBs), addressing allocation issues to ensure SDRs get where they are needed most, or considering more ambitious approaches such as new SDR asset classes with specific purposes tied to climate resilience (Stroebel & Wurgler, 2021).

The third priority is to develop an additional source of financing through a global network of hundreds of government-backed development banks at all multilaterals, regional, and national levels as the most direct way to increase the availability of development financing.

These banks take a long-term view to counter the cyclical trend of private finance and have local (national) expertise to create tailored solutions in different countries and regions. Climate finance from MDB not only targets the technical part of the transition but also supports communities in managing the economic and social costs of the green transition.

Developed countries can use shareholder rights to increase the capitalization of MDBs so that MDBs and regional development banks can seek new members to have more capital to support green investment activities (Cheng Hoon et al, 2024).

The fourth priority is how to mobilize private finance towards climate goals. Along with the use of incentives, discipline in the form of regulatory measures is needed to promote effective investment and align private financial flows with the Paris Agreement.

While new climate-related tools such as environmental, social, and governance financing activities, green bonds, and climate debt swaps show greater awareness of climate change, they are still much smaller in scale than required (Gasparini & Tufano, 2023).

In addition, there is a clear risk of greenwashing requiring increased regulatory scrutiny, otherwise, these tools will become a hindrance to exacerbating financial challenges.

These priorities show that the world has a starting point to ensure that a new target for climate finance can meet the challenge of the current context, thereby supporting all developing countries to achieve their climate goals.

3.1.2. Challenges to mobilizing climate finance resources

According to figures presented at the 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27), the world will need between $4 trillion and $7 trillion per year to make the transition towards sustainable development and meet the goals of the Paris Agreement on climate change. Particularly for developing and emerging countries, the total annual demand for climate finance is estimated to reach $1.3 trillion by 2025 and up to $2.4 trillion by 2030. This money is needed to phase out fossil fuels, invest in renewable energy and low-emission technologies, as well as deal with the impact of extreme weather events (Ellis & Pillay, 2017).

This will be a big challenge when financial commitments do not keep up with demand. Since COP15 in Denmark in 2009, countries have pledged to mobilize $100 billion a year to support developing nations to cope with climate change and set targets for implementation by 2020. However, this goal was missed. In 2020, countries made only 83.3 billion USD. Financial assistance is still voluntary with no written binding. Meanwhile, with a demand of $1.3 trillion a year, the climate finance needed by developing countries is more than 10 times higher than the $100 billion. According to UN Secretary-General Antonio Guterres: "*It is time for a historic treaty under which richer countries provide finance and technology along with support from multilateral development banks and technology companies to help emerging economies accelerate their transition to* renewable energy. *That model is necessary for all of us*."

3.2. The current state of climate finance for developing countries

3.2.1. Climate finance mobilization channels

In 2020, the initial target year of the US$100 billion target under the United Nations Framework Convention on Climate Change (UNFCCC), total climate finance provided and mobilized from developed countries to developing countries reached US$83.3 billion with an increase of 4% compared to 2019. This means that the total amount of climate finance needed to be mobilized from financially developed countries is still $16.7 billion short of the target. Consider trends per component over the available period: Climate public finance (bilateral and multilateral) accounts for the majority of the total. This source increased by 80% between 2013 and 2020 (Figure 1)

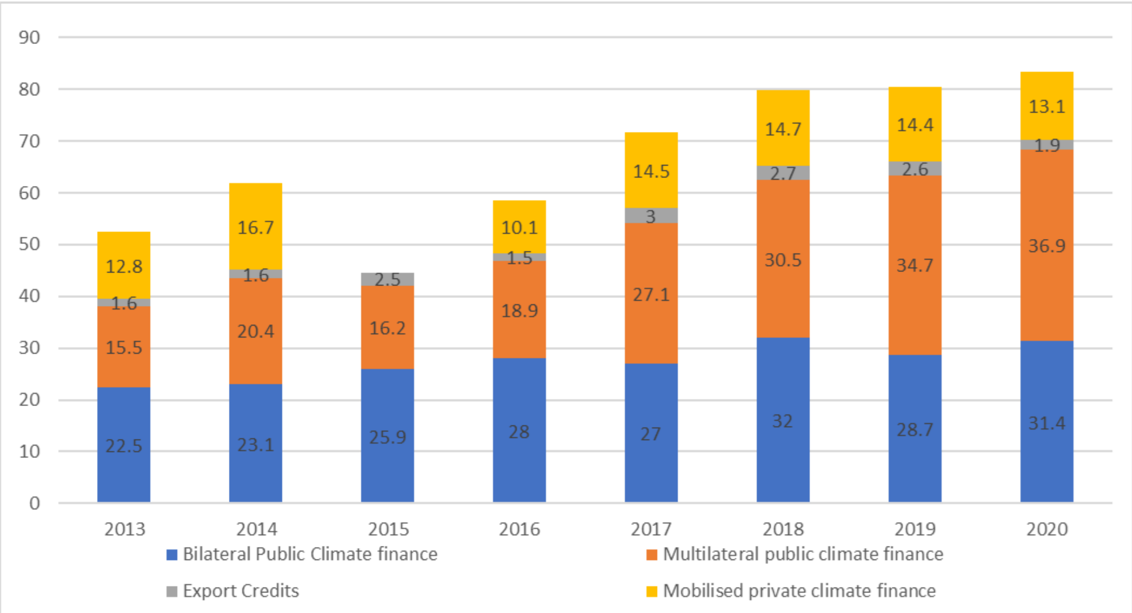

Figure 1: Sources of mobilization of climate finance in 2013-2020 (USD billion)

Source: Organisation for Economic Co-operation and Development, OECD

In public climate finance, multilateral sources coming from developed countries increased by 138% between 2013 and 2020, while bilateral sources increased by only 40% over the same period (Table 1). This shows that cooperation between countries in providing financial resources for climate issues is an increasing concern (Eyckmans et al, 2013).

At the aggregate level, it is difficult to determine the impact of the COVID-19 pandemic on the realization of the USD 100 billion target. Covid-19 may have slowed the progress of climate finance projects for some providers and recipients of individual climate finance sources. However, the increase in total climate finance in 2019-2020 of 4% is still slightly higher than in 2018-2019. This figure shows that Covid-19 has not only caused a negative impact on climate finance resources. This can be explained by changes in the structure of climate finance sources, namely that public climate finance increased while private climate finance decreased (Krueger et al, 2019).

Table 1: Details of climate finance sources from developed countries in 2013- 2020 (USD Billion)

	2013	2014	2015	2016	2017	2018	2019	2020
Bilateral Public Financing	22.5	23.1	25.9	28	27	32	28.7	31.4
Multilateral public financing, including:	15.5	20.4	16.2	18.9	27.1	30.5	34.7	36.9
+ Multilateral Development Bank	13.0	18.0	14.4	15.7	23.8	26.7	30.5	33.2
+ Multilateral Climate Fund	2.2	2	1.4	2.6	2.9	3.5	3.8	3.5
+ Inflow for multilateral organizations	0.3	0.4	0.4	0.6	0.5	0.3	0.3	0.2
Export Credit	1.6	1.6	2.5	1.5	3	2.7	2.6	1.9
Mobilised private climate finance	12.8	16.7	NA	10.1	14.5	14.7	14.4	13.1
+ By bilateral public climate finance	6.5	8.1	NA	5.2	4	3.7	5.8	5.1
+ By multilateral public climate finance attributable to developed countries	6.2	8.6	NA	4.9	10.5	11	8.6	8
Total	**52.4**	**61.8**	**NA**	**58.5**	**71.6**	**79.9**	**80.4**	**83.3**

Source: Organisation for Economic Co-operation and Development, OECD

3.2.2. Allocation of climate finance by climate theme and economic sector

At COP21 in Paris, the parties demanded that the allocation of investment capital must ensure a balance between adaptation and mitigation goals. However, a recent report by the Organisation for Economic Co-operation and Development (OECD) in 2019 shows that countries are failing to meet the aforementioned goals and balances (Painter, 2020). Finance for climate change mitigation and adaptation issues provided and mobilized by developed countries grew in absolute growth in the period 2016-2020. However, from 2019 to 2020, while climate change adaptation finance increased by US$8.3 billion (41%), disaster mitigation finance decreased by US$2.8 billion (5%). In 2020, mitigation accounted for the majority (58%) of all climate finance provided and mobilized (Figure 2).

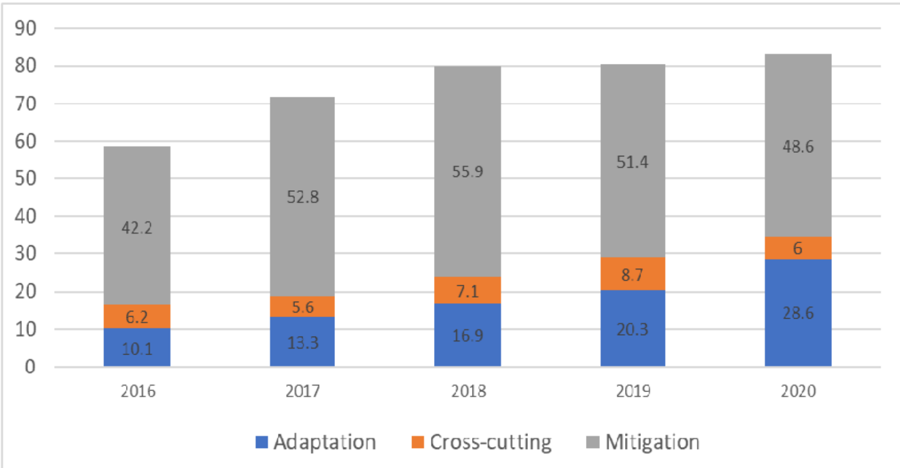

Figure 2: Allocation of climate finance resources by climate theme in 2016-2020 (USD Billion)

Source: Organisation for Economic Co-operation and Development, OECD

Financing for climate change mitigation focuses on activities in the energy and transport sectors. Between 2016 and 2020, these two sectors continued to account for nearly half (46%) of all climate finance provided and mobilized. In contrast, adaptive finance focuses on activities in the water supply and sanitation sector; and agriculture, forestry, and fisheries, which together account for 17% of all climate finance provided and mobilized (Figure 3).

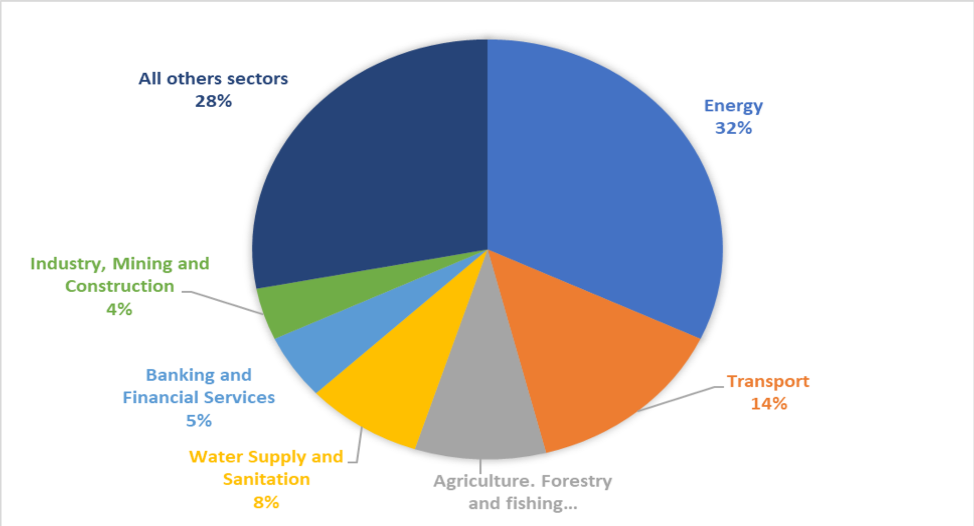

Figure 3: Financial resources for developing countries by economic sector in 2016-2020

Source: OECD

3.3. Climate finance mobilization for developing countries by instruments

Following the trend of previous years, public climate finance in 2020 was mainly in the form of loans (71% or $48.6 billion, including both concessional and non-concessional loans) and to a lesser extent non-refundable grants (26% or $17.9 billion). From 2016 to 2020, annual funding increased by $5.6 billion (up 46%) and the size of public loans increased by $15.3 billion (also up 46%)

Table 2: Climate finance mobilization by instruments (USD Billion)

	2016	2017	2018	2019	2020
Loans	33.3	38.6	46.5	45	48.6
Grants	12.3	13.8	13.9	16.7	17.9
Equity	0.8	0.9	1.1	1.5	1.6

Source: OECD

Public finance providers mobilize private finance through different types of mechanisms. In the 2016-2020 period, direct investment in companies and specific projects, usually made for large infrastructure projects, accounted for the largest proportion at 43%. The form of guarantee, introduced to reduce risk, came in second with a share of 19%. However, the relative share of different mechanisms in the total private finance mobilized by developed countries fluctuates over the years.

3.4. Allocation of climate finance by income group and geography

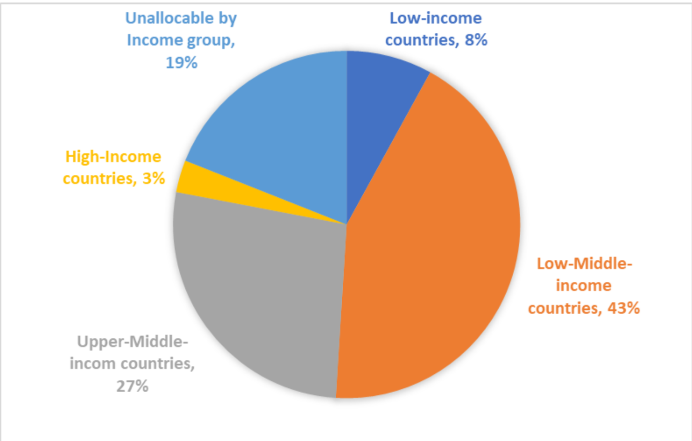

Figure 4: Allocation of climate finance by income group 2016-2020
Source: OECD

In Figure 4, by income group, lower-middle-income countries are the main beneficiaries, accounting for 43% of total climate finance provided and mobilized between 2016 and 2020. This is followed by upper-middle-income countries (27%), low-income countries (8%), and high-income countries (3%).In 2016-2020, Asia was the main beneficiary of climate finance provided and mobilized by developed countries, accounting for 42% of the total. This is followed by Africa (26%), the Americas (17%), Europe (5%) and at least Oceania (1%) (Table 2)

Table 3: Allocation of climate finance from developed countries by geography in 2016-2020

Geographical area	Value (billion USD)	Density (%)
Asia	31.2	42.0%
Europe	3.4	4.6%
Americas	12.5	16.8%
Africa	19.5	26.2%
Oceania	0.5	0.7%
Unknown	7.2	9.7%
Sum	***74.3***	***100%***

Source: OECD

4. Policy recommendations for Viet Nam in mobilizing and using climate finance

According to the Global Climate Risk Index, Vietnam is one of the country's most at risk of natural disasters due to climate change when compared to other countries in the world. The most vulnerable sectors are agriculture and food security, natural ecosystems, biodiversity, water resources, public health, housing, and technical infrastructure. The cost of adapting to climate change in Vietnam is increasing and is expected to account for 3-5% of national GDP per year by 2030.

According to the United Nations Development Programme (UNDP) and figures from the Government of Vietnam, the country can only cover 30% of the cost of adaptation activities, so more funding for international adaptation needs to be mobilized. Vietnam's proposed nationally determined contribution (NDC) commitment to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) shows that the country intends to spend about 0.21% of total GDP on adaptation activities of ministries. In addition, if Vietnam aims to spend 1.5% of total GDP on these activities, it still needs to mobilize an additional US$3.5 billion per year, or US$35 billion in the period 2021-2030.

With the general context of the world and the actual situation in Vietnam to increase the scale of mobilization and improve the efficiency of using climate finance resources for Vietnam from 2025 to 2030, some policy recommendations are made as follows:

First, Vietnam's climate finance policymakers need to focus on diversifying mobilization channels. In addition to multilateral and bilateral sources through government channels, mobilization channels through private organizations, non-governmental organizations as well as domestic and foreign enterprises. To do this, it is essential to develop a clear strategy and objectives for the mobilization and use of climate finance resources. Because thereby, private organizations or businesses, when contributing financial resources to climate issues, will clearly see the direct and indirect benefits that they can enjoy (Nordhaus, 2019).

Second, in order to ensure a balance between adaptation and risk reduction goals, Vietnamese authorities must carefully assess climate and environmental issues in Vietnam such as water and soil environmental issues, air environment, pollution problems in industrial parks, craft villages, etc. This is to provide an important basis for building projects with the dual objective of clearly adapting or mitigating risks. On that basis, it will be easier to mobilize resources for climate issues from international to domestic because no donor will be willing to spend financial resources on activities that do not have clear goals.

Third, mobilizing climate finance is a major challenge for the world, not only Vietnam, in which transparency is an issue that both donors and grantees are concerned about. Transparency is an important tool for building trust between developed and developing country partners. It also helps improve the efficiency of climate finance. Viet Nam should pay attention to improving the quality and internationally standardizing methods of assessment, reporting, and disclosure of information on climate issues. The establishment of an easily accessible database on climate issues at the national level will be a prerequisite for Viet Nam to have access to climate finance from developed countries.

Fourth, the issue of combating climate change and solving environmental issues is not only related to climate and environmental issues but also related to other issues such as poverty eradication, gender equality, etc. Therefore, projects receiving climate finance sources need to work towards multi-objective identification for activities using climate finance. If this is done, it will increase the efficiency of climate finance resources, thereby also better convincing to scale up mobilization for further projects and activities.

5. Conclusion

Through the analysis of the context, challenging issues as well as the situation of mobilizing and using climate finance sources from developed countries to developing countries, Vietnam needs to change its policies. Some policy recommendations made in this study aim to enhance Vietnam's ability to mobilize and improve the efficiency of using climate finance resources in real conditions. The above policy recommendations address only a few aspects of climate finance. This topic will be researched and discussed more in the future.

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Promoting the Green Bond Market in Vietnam: Current Situation and Recommendations

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Abstract

Promoting long-term sustainable economic prosperity is a key focus for most countries worldwide. In addition to other important issues such as inflation, unemployment, and poverty reduction, environmental pollution and global warming are pressing concerns that are receiving significant attention from many nations. At the United Nations Climate Change Conference (COP 21), participating countries committed to cooperating in reducing pollutant emissions to limit the global temperature increase to below 2°C compared to pre-industrial levels, and to strive to keep this increase to 1.5°C according to the Paris Agreement. Vietnam is one of the countries facing severe damage due to the adverse impacts of climate change. Acknowledging these challenges and fulfilling the commitments made at the Conference, the Vietnamese government has pledged to reduce emissions by 8% compared to the baseline scenario by 2030. It has introduced strong response measures, including the issuance of green bonds. This article focuses on evaluating the current development status of the green bond market in Vietnam. Based on this, the authors propose several recommendations to promote the development of the green bond sector to achieve the goal of net zero emissions by 2050.

Keywords: *Green bonds, sustainable development, COP 21, COP 26, COP 27, COP 28.*

1. Introduction

In recent years, Green Bonds have become an increasingly prominent issue on a global scale, serving as a growing source of funding for green projects that contribute to reducing greenhouse gas emissions, and environmental pollution, and protecting natural resources - priorities for many countries. In Vietnam, the government has also made strong commitments towards building a sustainable green economy, including specific obligations to develop the green bond market, and ensuring capital for green and environmentally friendly projects.

At the COP21 Conference, held from November 29 to December 13, 2015, 195 countries participating in the United Nations Climate Change Conference adopted the Paris Agreement - a historic global accord to combat climate change. The agreement marked a significant breakthrough in the United Nations' efforts over more than two decades to persuade governments to cooperate in reducing pollutant emissions and limiting the rise in global temperatures. Countries, including Vietnam, actively contributed to the success of the conference. The Vietnamese government made strong commitments to join the international community in addressing climate change, including a pledge to contribute 1 million USD to the Green Climate Fund for 2016-2020, with a vision toward 2030.

At COP26, Vietnam committed to achieving net-zero emissions by 2050 and reaffirmed this commitment at COP27 and COP28. To realize this commitment, the government has issued the National Green Growth Strategy for the 2021-2030 period, with a vision toward 2050, along with orientations, plans, and investment solutions for green growth and transition. As one of the countries most severely affected by climate change, Vietnam needs to make further efforts to fulfill its commitments at COP21, COP26, COP27, and COP28. In this context, green bonds play a crucial role in the investment capital structure for green development. Developing the green bond market in Vietnam can be seen as a key factor in reducing carbon emissions and contributing to the promotion of sustainable growth goals.

2. Literature review

The term "Green Bonds" first emerged around 2007-2008 when the European Investment Bank and the World Bank issued their first green-themed bonds. According to the World Bank, green bonds are a type of bond issued to raise capital from investors to fund green projects or environmentally sustainable activities. This is done to support the development and expansion of clean industries, reduce emissions, enhance renewable energy, and protect natural resources (WB, 2015).

According to the Climate Bonds Initiative (CBI, 2020), green bonds are bonds issued to raise funds for climate change solutions, issued by governments, banks, local authorities, or corporations. These bonds are labeled as green bonds in the form of debt securities, including securitization, private placements, and guaranteed bonds.

According to the Green Bond Principles (GBP) 2018, green bonds are any type of bond instrument where the proceeds will be exclusively applied to finance or refinance, in part or full, new or existing eligible green projects that comply with the four core components of the GBP.

In Vietnam, green bonds are identified as a financial product and a strategy aimed at sustainable development. The definition of green bonds is provided in Decree No. 81/2020/ND-CP issued on July 9, 2020, and is stated in Article 4 as follows: “Corporate green bonds are corporate bonds issued to invest in environmental protection projects as prescribed by the Law on Environmental Protection,” and in Decree 83/2023/ND-CP issued on November 29, 2023, regarding the issuance, registration, depository, listing, and trading of debt instruments, it is stated as follows: “Green bonds are a type of government bond issued to invest in projects related to environmental protection activities as prescribed by the Law on Environmental Protection and fall within the project list allocated public investment capital as regulated by the Law on Public Investment and the Law on State Budget.”

In summary, green bonds are understood as a type of fixed-income security and a capital-raising instrument to fund specific projects related to the environment. The proceeds from the issuance of green bonds are committed to being invested in programs that mitigate the impacts of climate change, environmental projects, and projects that consider environmental benefits.

Green bonds are the main channel for providing capital for green and sustainable development projects, playing a crucial role for the nation, enterprises, and investors. Firstly, the government can use green bonds to finance projects that improve the environment and reduce emissions, such as renewable energy, green transportation, and waste management and treatment. Green bonds attract investment capital from international investors interested in the environment, helping to improve the national image and reduce environmental risks. Green bonds also support international organizations in investing in environmental projects in developing countries, promoting sustainable development and community benefits.

The development of green bonds helps the nation mobilize resources for environmental projects and innovate the financial market. Green bonds are appealing to governments, nations, and corporations, helping to improve sustainability ratings and meet international commitments such as the Paris Agreement, including reducing emissions, protecting biodiversity, and preventing land degradation. The issuance of green bonds supports the financing of projects that achieve these commitments and contributes to global sustainable development.

Secondly, green bonds provide financial support for enterprises, enhancing their credibility and image in terms of social responsibility and environmental protection. Investing in green projects helps enterprises attract investors interested in sustainability, while also reducing capital costs due to the typically lower interest rates on green bonds compared to conventional bonds, increasing competitiveness. Green bonds also require enterprises to comply with environmental criteria, ensuring that projects have a positive impact, contributing to sustainable development, and minimizing negative environmental impacts.

Thirdly, green bonds help investors raise capital to address sustainable development challenges. Green bonds support investors in meeting environmental, social, and governance (ESG) criteria. The diverse green bond market helps spread risks, provides attractive interest rates, and offers more flexibility compared to bank loans. Green bonds also raise investor awareness of pollution and emissions, while promoting adherence to the Principles for Responsible Investment, enhancing corporate reputation. With the trend towards greening, the green bond market will continue to develop, attracting more potential investors.

According to the GBP (2018), green bonds are categorized into four types: Standard Green Use of Proceeds Bond, Green Revenue Bond, Green Project Bond, and Green Securitized Bond.

Standard Green Use of Proceeds Bond is the most common type and directly links the proceeds to eligible green projects. The issuer commits to using the raised funds to finance or refinance these projects.

Green Revenue Bond is a type of bond where the issuer is not liable, but instead, the debt obligation is tied to revenue streams from specific sources such as taxes, fees, etc., and the proceeds from the bond issuance can be used to fund green projects related to or unrelated to the issuance purpose. This bond is similar to conventional bonds but with an additional "green" feature, tied to environmental benefits.

Green Project Bond is issued to finance a single green project, with the proceeds from the bond directly allocated to that project. The investor's return is directly related to the project's performance.

Green Securitized Bond is a type of bond issued based on assets secured by green projects, including covered bonds, asset-backed securities (ABS) issued by professional debt trading companies, and other structured securities.

3. Results

3.1. Global trend of green bond development

In the current phase, green growth and sustainable development have become global objectives and have received significant attention from governments, international organizations, and the private sector. Over the past five years, global financial resources for climate change adaptation have seen positive changes, particularly with the development of the green bond market. The green bond market has grown worldwide over the past decade, funding renewable energy projects, energy efficiency, and other environmentally friendly industries to combat climate change. According to the International Energy Agency (IEA), to halve global emissions by 2050, the world will need 46 trillion, equivalent to 1 trillion per year. In this context, green bonds are seen as a new channel for attracting capital and an effective solution that could help raise hundreds of billions of dollars per year for developing a green and sustainable economy.

In reality, the trend of issuing green bonds has long been established worldwide with green and environmentally friendly projects aimed at achieving the dual goals of economic growth and environmental protection. The growth rate depends on the priority and financial policies of each country and region.

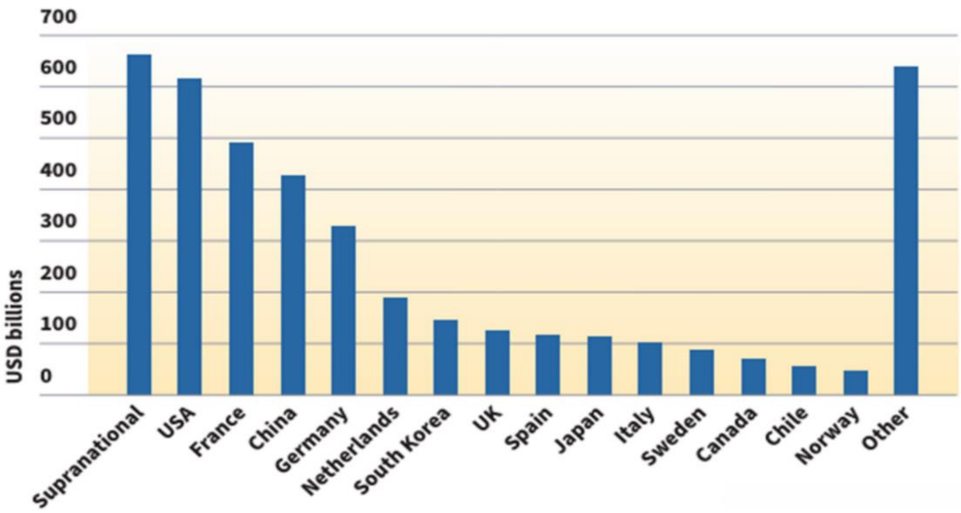


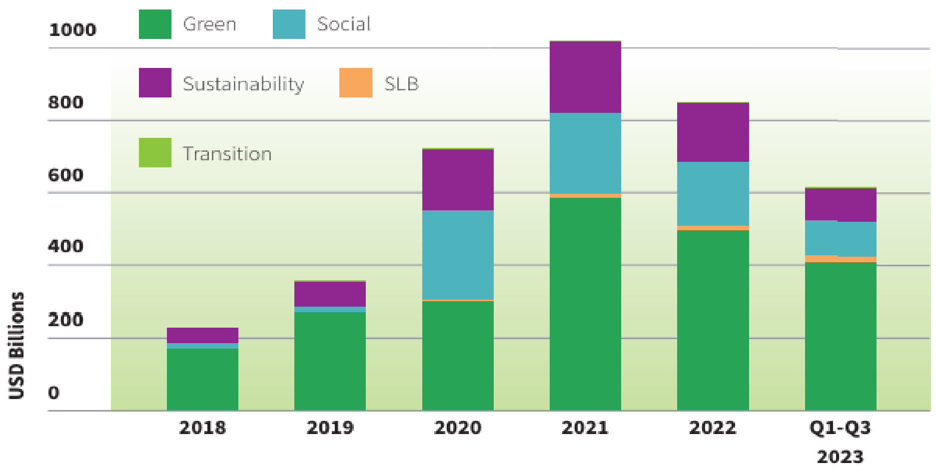
Figure 1: The total volume of GSS + issuance as of the end of 2023 (USD billion)

Source: Climate Bonds Initiative

According to the Climate Bonds Initiative (CBI), by the end of 2023, the total volume of GSS+ issued reached 4.2 trillion USD, originating from intergovernmental sources in 103 other countries. The largest GSS+ issuance volume is in supranational regions, amounting to approximately 660.7 billion USD, with the United States (612.6 billion USD), France (488.2 billion USD), and China (431.28 billion USD) being the largest national sources. Additionally, South Korea (149 billion USD) and Chile (53.4 billion USD) are the only emerging markets (EM) appearing in the top 15 developed countries with strong supportive policies, contributing to the development of both local and international green bond markets.

The volume of GSS+ issuance from the beginning of 2023 to date amounts to 618.2 billion USD in GSS+ debt valued up to the end of Q3 2023, representing 5% of the total debt issued. Among this, green bonds account for approximately 67%, social bonds for 16%, sustainability bonds for 14%, sustainability-linked bonds for 3%, and unfiltered convertible bonds account for only 0.3%.

Figure 2: GSS+ Issuance Structure by Bond Type



Source: Climate Bonds Initiative

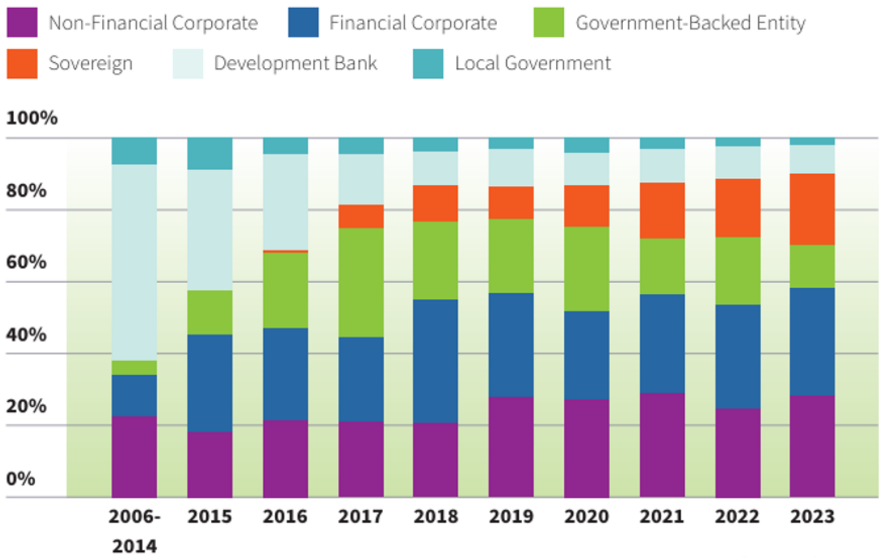


Figure 3: Volume of Green Bond Issuance

Source: Climate Bonds Initiative

The report also indicates that the volume of green bond issuance has been increasing steadily over the years. Notably, global green bond issuance reached a peak of 587.6 billion in 2023, marking a new global record and a 15.23% increase compared to 2022 (509.5 billion USD). Among this, sovereign green bond issuance was adjusted to 120 billion USD, up 45% from 83 billion USD in 2022. Currently, more than half of the global green bond issuance in 2023 originates from Europe (53%), amounting to 309.6 billion USD, a 23% increase from 250.8 billion USD in 2022. Notably, the top ten largest issuers account for 39% of the volume, with the United Kingdom leading with 22.5 billion USD (18.3 billion GBP) through multiple reopenings of its sovereign green bonds. The Asia-Pacific region is the second-largest green bond issuer in 2023, contributing one-third of the total issuance at 189.4 billion USD, with 44% of this coming from China.

Figure 4 provides a comprehensive view of the structure and proportion of green bonds issued by different entities. According to this, private sector issuers in non-financial industries and financial enterprises accounted for 57% of the total green bond issuance in 2023, equivalent to 335 billion USD. Non-financial issuers contributed 29% of the market share in 2023, distributed across 692 green financial instruments from 384 issuers, with a total value of 171.8 billion USD. An Indian company, Renew Power, conducted the largest non-financial transaction with a green loan of 7.8 billion USD. Additionally, issuers from industries ranked second, with 28% of the green bond volume market share, issuing 572 green financial instruments totaling 163.4 billion USD.

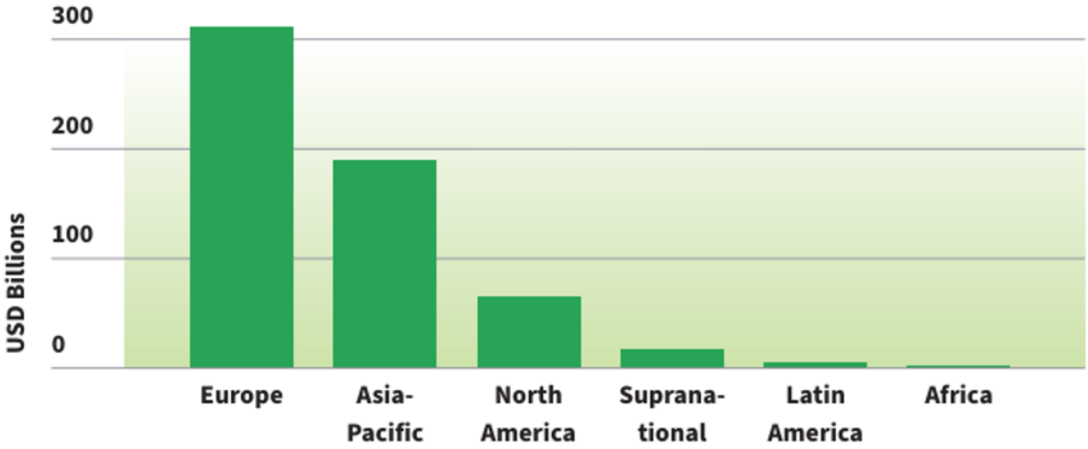


Figure 4: Green Bond Issuers

Source: Climate Bonds Initiative

3.2. The current state of green bond development in Vietnam

Vietnam ranks 6th among countries most affected by climate change and is also a rapidly growing economy, with a GDP growth rate of 5.05% in 2023, equivalent to 430 billion USD, higher than the same period last year, with a positive trend where each quarter surpasses the previous one. According to estimates from the World Bank, Vietnam's capital needs for green development from 2022 to 2040 are expected to reach 368 billion USD. The demand for capital to achieve green growth is substantial, so not only the government but also the business community needs to leverage the capital markets to mobilize investment capital to meet these goals. The Vietnamese government has implemented numerous reforms and policies to support corporate bond issuance, particularly green bonds, and has also issued public-private partnership mechanisms to attract foreign investment for sustainable development in the future effectively.

According to statistics from the German Agency for International Cooperation (GIZ), Vietnam is undergoing significant changes through two global development trends: green transformation and digital transformation. This dual transformation, known as the "Dual Transition," is closely linked to the goals of green growth, climate change adaptation, environmental protection, and achieving net-zero emissions by 2050, along with a just energy transition (JETP).

Compared to other countries, the green bond market in Vietnam has developed more slowly. However, in recent years, several green bond-funded projects have been implemented in Vietnam. Statistics show that Vietnam issued 1.157 billion USD in green bonds from 2019 to 2023. To date, Vietnam's green financial market has been built on three components: the green credit market, the green securities market, and the green bond market. All green bonds have been issued by the government, with the majority of the proceeds (57%) used for renewable energy - a sector of primary interest for Vietnam—alongside water, waste, and agriculture sectors (MOF, 2021). Vietnam's efforts to develop the green bond market have been supported by international organizations such as the Global Green Growth Institute (GGGI), which aims to enhance the legal framework and attract international investment. These advancements demonstrate Vietnam's commitment to promoting sustainable development and minimizing negative environmental impacts.

Regarding corporate green bonds, GIZ has collaborated with the Ministry of Finance, the State Bank of Vietnam, the State Securities Commission, the Hanoi Stock Exchange, the Ho Chi Minh City Stock Exchange, and the International Finance Corporation (IFC) to develop a project for corporate green bonds and green bonds of financial institutions and to pilot the issuance of corporate green bonds by companies in the VNSI (Top 20 sustainable development companies) and major commercial banks in Vietnam as part of a cooperative program since 2018.

In late August 2019, Trung Nam Solar Power Joint Stock Company successfully issued VND 2,100 billion in private bonds with a 9-year term, and Trung Nam Joint Stock Company (which owns 70% of Trung Nam Solar Power Joint Stock Company) also successfully issued VND 945 billion with a 5-year term, with a floating interest rate equal to a 2-year term deposit rate plus a margin of 3.5% per year, with the first year at 10.5% per year. The total amount raised by these two companies was VND 3,045 billion, which was used for a solar power project in Ninh Thuan. In early October 2019, Bamboo Capital Joint Stock Company (BCG) announced plans to issue 900,000 convertible bonds in Q4 2019, with a 5% annual interest rate and a 3-year term, with VND 350 billion earmarked for investment in solar energy projects, VND 500 billion for real estate projects, and VND 50 billion for additional working capital.

Additionally, several companies have recently issued green bonds on the international market, notably BIM Land and VinGroup. BIM Land, part of BIM Group, successfully raised 200 million USD on the international market in 2021. Meanwhile, VinGroup pioneered the issuance of sustainability bonds with a 425 million USD equity-linked issuance (FiinGroup, 2022). In terms of green debt issuance, by October 2020, Vietnam had completed four green debt issuances with a total value of approximately 283.9 million USD (State Securities Commission, 2021). In 2021, the total value of green, social, and sustainability (GSS) debt issuance reached 1.5 billion USD, nearly five times the 0.3 billion USD in 2020, and has maintained stable growth for three consecutive years.

In 2020, six issuances totaled 770 million USD, and in 2021, another six issuances totaled 2.8585 billion USD, despite these being years when the global economy, including Vietnam's, faced severe challenges due to the complex developments of the Covid-19 pandemic. Such achievements are attributed to the long-term improvement in investment efficiency accumulated over the 2011-2020 period, including (i) A positive shift in the structure of investment capital sources with an increase in the proportion of capital from the non-state sector and the FDI sector; (ii) The government issued regulations related to green bonds early on, directing and guiding ministries and agencies to develop the green bond market aimed at a sustainable economy. As a result, the number of green bond issuances in Vietnam continued to rise in 2020-2021, even as the economy was affected by the Covid-19 pandemic.

In July 2022, for the first time, Vietnam's market saw a green bond issuance based on the principles published by ICMA in 2018. EVNFinance (Electricity Finance Joint Stock Company) issued 73.7 million USD in green bonds with an interest rate of 6.7% per annum and a 10-year term, partially guaranteed by GuarantCo. EVNFinance's move was seen as a significant "boost" for Vietnam's relatively modest and nascent green bond market.

Green bonds have started to gain recognition and are being increasingly used, providing an effective channel for raising capital to finance green projects. However, the issuance value of green bonds remains insignificant compared to the scale of Vietnam's bond market (104.6 billion USD in 2019 and 324.1 billion USD in the first nine months of 2020). Most enterprises have yet to participate in raising capital in the green bond market, as most current green bond issuance projects are funded by the government and local authorities.

Regarding commercial banks, on October 25, the Bank for Investment and Development of Vietnam (BIDV) became the first bank to successfully issue green bonds under the Green Bond Principles of the International Capital Market Association (ICMA) in the domestic market, with a scale of VND 2,500 billion. This is the first time Vietnam's capital market has witnessed a domestic bond issuance with a Green Bond framework rated by the international credit rating agency Moody's. BIDV achieved a very high rating from Moody's for its Green Bond Framework for financial institutions. The proceeds from the bond issuance will be used to finance green projects, energy-saving initiatives, emission reduction, and environmental protection, in line with BIDV's Green Bond Framework. As of September 30, 2023, BIDV had financed approximately 1,500 customers with 1,900 green credit projects/plans, with a total outstanding loan balance of VND 71,000 billion, accounting for approximately 5% of BIDV's total outstanding loans, up 11% compared to 2022.

Table 1: Some Green Bond-Funded Projects Implemented in Vietnam

Time	Issuing entities	Project scale	Purpose	Additional Information
10/2016	Ho Chi Minh City Finance and Investment State-owned Company (CBI, 2019)	23 million VND	Sustainable Water Management and Adaptation.	Local government bonds with maturities of 10, 15, 20, and 30 years.
8/2019	Trung Nam Solar Power Joint Stock Company (Vu Nu Nhu Quynh, 2021)	2,100 billion VND	Solar power project in Ninh Thuan.	9-year maturity, floating interest rate equivalent to the 2-year deposit rate plus a 3.5% margin per year, with the first year's rate set at 10.5% per year.
8/2019	Trung Nam Solar Power Joint Stock Company (Vu Nu Nhu Quynh, 2021)	945 billion VND	Solar power project in Ninh Thuan.	5-year maturity, floating interest rate equivalent to the 2-year deposit rate plus a 3.5% margin per year, with the first year's rate set at 10.5% per year.
7/2022	EVNFinance (EVNFC, 2022)	1.700 million VND	Funding projects that meet the criteria outlined in the EVNFinance Green Bond Framework.	Guarantor: GuarantCo. Fixed interest rate, maturing in 2032, creating a direct debt obligation, not subordinated, with partial payment guarantee equivalent to 1,100 billion VND.
9/2023	Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)	71.000 billion VND	Funding for approximately 1,500 customers with 1,900 green projects.	BIDV has financed around 1,500 customers with 1,900 green projects, with a total outstanding loan amount of up to 71,000 billion VND, accounting for 5% of the bank's total loans, an 11% increase compared to 2022.
10/2023	Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)	2.500 billion VND	Funding for green projects, energy savings, emission reduction, and environmental protection according to the principles of the International Capital Market Association (ICMA).	2,500 billion VND in bonds issued for the first time under an unsecured structure, not subordinated debt, and without payment guarantee.

Source: Compiled by the authors

4. Conclusion and Recommendations

In the context of Vietnam's ongoing progress in environmental protection, green bonds are an essential mechanism to mobilize financial resources for sustainable development and environmental protection projects. Therefore, the first step is to establish standards and legal frameworks for green finance, followed by the development of the green bond market. With the Action Plan for Climate Change Adaptation and Sustainable Green Growth until 2030, and the vision for 2050, along with the current state of the green bond market in Vietnam, it is evident that more efforts are needed to deploy, promote investment, and develop green bonds to enhance their role and effective application in green and sustainable growth. The authors propose five main solutions as follows:

First, continue to build and improve mechanisms and policies. The government should complete the principles for issuance and establish a roadmap and suitable policies and programs, including measures such as green subsidies, tax incentives, direct grants, and loan support for issuers. For the green bond market, authorities should provide long-term, stable commitments to safeguard investors' interests and consider increasing the discount rate for green bonds compared to conventional bonds. Additionally, improving liquidity for green bonds by allowing banks to accept them as mandatory reserve assets should be considered.

Second, develop standards and legal frameworks. The government needs to establish clear standards and guidelines for green bonds that align with international standards, including environmental, social, and governance criteria that green development projects must comply with (such as Green criteria, ESG reporting, independent verification, and risk management).

Third, enhance awareness of green bonds. Strengthen information dissemination, education, and advocacy about green bonds to various stakeholders, including investors, businesses, regulatory bodies, and the public, to increase understanding of the benefits of green bonds for the environment and sustainable development.

Fourth, strengthen the role of banks. Enhance the intermediary role of banks in issuing and managing green bonds due to their favorable conditions such as high credit ratings and professional management. Many green projects in developing countries are small-scale and do not meet the minimum requirements of large financial institutions. Thus, bundling small-scale projects and using banks as intermediaries could achieve better financing terms for green projects. The government could consider establishing a green investment bank dedicated to green investments. This green bank model could effectively channel private investments towards climate adaptation and mitigation projects. In the short and medium term, Vietnam should not only further explore the technical aspects of establishing and operating a green bank but also improve data collection based on experiences from green bond markets in emerging economies.

Fifth, promote domestic participation and international standards. Implement policies to encourage domestic entities to participate in the certification and labeling of green bonds according to international standards. Proactively develop projects and programs to access green financing from international organizations such as the World Bank (WB), Asian Development Bank (ADB), and International Finance Corporation (IFC). Simultaneously, additional guidelines should be issued for assessing the green credentials of projects or project components periodically. Furthermore, guidance should be provided on how to handle cases where projects or project components fail to meet green standards after each assessment, including remediation processes, violation disclosures, and re-evaluation after corrective actions are completed.

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Criteria Weights Evaluation for Financial Performance of Insurance Companies Regarding the Sustainable Development

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Abstract

The financial performance of insurance companies holds significant implications for policyholders, shareholders, employees, intermediaries, regulators, and potential investors. Ratios such as the current, solvency, return on assets, and leverage ratios are calculated to assess life insurers' liquidity, solvency, profitability, and leverage. A single metric cannot cover the entire performance spectrum, so various factors provide a more comprehensive evaluation. A robust approach is required for measuring financial performance and identifying key influences. Multi-criteria techniques are valuable in assessing firms' performance relative to competitors, offering a single score in a multidimensional context. Fuzzy theory has been used to rank insurers, select life insurance products, identify models, and evaluate client risk levels. However, a research gap exists in applying fuzzy AHP to determine criteria weights for insurance companies' financial performance regarding sustainable development. This study proposes a fuzzy AHP method to establish criteria weights. The results indicate that the most significant factors are the sale profitability and premium retention ratios. In contrast, the current and solvency ratio are less critical to the research findings. The loss ratio and premium growth rate are ranked moderately.

Keywords: *Fuzzy AHP, criteria weights, financial performance, insurance companies, Fuzzy theory*

1. Introduction

Insurance involves sharing risks among all insured parties to lower the cost of unforeseen and costly incidents for individuals (Chen & Lu, 2014). The insurance industry is a significant component of the financial services sector in almost all developed and developing countries, contributing to economic growth, resource allocation efficiency, reduced transaction costs, liquidity creation, investment economies of scale, and financial loss distribution (Sharma et al., 2018). Ecer & Pamucar (2021) noted the crucial role of insurance in modern daily life. Insurers are fundamental to economies as they manage risks for individuals, companies, and countries, alleviating concerns about unexpected incidents. Dwivedi et al. (2021) indicated that the main reason for having insurance is its provision of security in multiple forms, such as generating financial resources, fostering economic growth, maintaining commerce, ensuring business and family stability, and promoting savings for future goals. Insurance companies protect against risks like property damage, health issues, and financial losses in return for premiums covering expenses and anticipated risks (Van Gestel et al., 2007). Insurers' profitability is affected by internal factors related to company-specific characteristics and external factors involving industry features and macroeconomic conditions (Kwaning et al., 2015). The performance of insurance companies enhances both individual firm market value and industry growth, ultimately benefiting the overall economy. This subject has received significant interest from regulators, financial experts, researchers, business managers, and the public (Sharma et al., 2018).

The financial performance of companies has attracted much attention, commentary, and interest from financial experts, researchers, the general public, and corporate management. It can be analyzed in terms of profitability, dividend growth, sales turnover, asset base, and capital employed, among other indicators. However, various disciplines have an ongoing debate about the best way to measure performance and the factors affecting it (Kwaning et al., 2015). Despite the various definitions, interpretations, and measurements of financial performance, there is no consensus on the best way to measure performance and identify the factors that affect financial performance(Sharma et al., 2018). The financial performance of insurance companies has direct implications for many stakeholders, including policyholders, shareholders, employees, intermediaries, regulators, and potential investors, making its measurement and assessment critical (Kaya, 2016). The performance of any business firm not only increases the market value of that specific firm but also leads to the growth of the whole sector, which ultimately leads to the overall prosperity of the economy. Ho et al. (2018) indicated that the 21st century has been marked by global crises like resource depletion, ongoing environmental degradation, and dramatic climate change, all threatening the survival of humankind. Many countries have addressed the issue of sustainable development. Enterprises are required to actively issue sustainable development reports that exhibit their commitments to protect the economy, the environment, and society and seek the maximum common interests of stakeholders and the public. As sustainable development becomes increasingly essential, internal and external stakeholders increase their influence on enterprises regarding business decisions. Khovrak (2020) pointed out that insurance companies have the potential to create guarantees to minimize risks for their customers, develop society, and invest in sustainable development. Jeaidi & Mezher (2017) also noted that the insurance industry plays an important role in helping corporate bodies safeguard their goods and services. Therefore, the sustainable development practices of insurance firms need further investigation. The sustainable development of enterprises should center on environmental, social, economic, and governance criteria and protect the rights of various stakeholders, which are beneficial for business opportunities and risk management of enterprises (Ho et al., 2018).

Assessing the factors that affect the performance of insurers regarding sustainable development has gained importance in the corporate finance literature because, as intermediaries, these companies are not only providing the mechanism of risk transfer but also help to channelize the funds in an appropriate way to support the business activities in the economy (Kwaning et al., 2015). Financial ratios such as the current, solvency, return on assets, and leverage ratios are calculated for life insurers, considering liquidity, solvency, profitability, and leverage (Bawa & Chattha, 2013). A single factor cannot reflect every aspect of a company's performance; therefore, using several factors allows a better evaluation of the financial profile of firms (Kwaning et al., 2015). Sharma et al. (2018) summarised the importance of evaluating insurers' performance determinants in corporate finance research. A comprehensive method is necessary to measure insurance companies' financial performance and identify influencing factors, with multi-criteria techniques that are particularly beneficial. These techniques provide a single score that assesses firms' performance in a multidimensional framework, offering an edge over traditional methods (Doumpos et al., 2012). There are numerous research using regression models to evaluate the financial performance of insurance companies, namely, Ishtiaq & Siddiqui (2019), Derbali & Jamel (2019), Ntwali et al. (2020), and Olarewaju & Msomi (2021). Most of the research used regression models to determine the relationship between the ratio and the financial performance of the insurance firms. Furthermore, most empirical analyses of financial performances use traditional statistical methods in which the usage of the variables with negative values are excluded, which throws some of the vital information out of the analysis (Suvvari et al., 2019). The fuzzy theory has been applied to rank insurance companies, choose life insurance products, identify alternative insurance models, and determine the risk level in client analysis of the insurance sector. However, research has yet to be conducted on determining criteria weights of financial performance for insurance companies regarding sustainable development through fuzzy AHP. This study proposes a fuzzy AHP method to fill this research gap. The proposed method consisted of five major steps. First, experts judged the importance of the criteria through linguistic values. Afterward, these linguistic values were presented by trapezoidal fuzzy numbers. These trapezoidal fuzzy numbers were defuzzified and normalized. Last, the final criteria weights were obtained, and a larger score represents the higher importance of the criterion. A numerical example was presented to demonstrate the process of assessing the importance of criteria for choosing insurance companies based on financial performance.

The rest of this paper is structured as follows. Section 2 covers a literature review on the financial performance of insurance companies and the fuzzy theory, fuzzy AHP method. Section 3 outlines the criteria for selecting the most suitable insurance companies based on financial performance. Section 4 introduces the fuzzy AHP model framework. Section 5 presents a numerical example demonstrating the proposed method's feasibility. Finally, Section 6 provides conclusions, discussing implications and future research directions.

2. Literature review

The evaluation and assessment of insurance companies' financial performance using regression models has garnered significant attention in recent research. Gatsi and Gadzo (2013) explored the impact of macroeconomic factors (such as inflation, exchange rates, and GDP) and firm-specific characteristics (including size, leverage, tangibility, risk premium growth, and age) on insurance company performance in Ghana. Barus et al. (2017) indicated that out of the three determinants of capital adequacy, only cash flow had a statistically significant impact on the financial performance of insurance firms. Capital adequacy plays a substantial role in influencing the financial performance of insurance companies in Kenya. Suvvari et al. (2019) estimated the financial performance of 24 Indian life insurance companies from 2013 to 2016 using Grey relational analysis (GRA). The main finding was that profitability ratios with negative values play a crucial role in determining the financial performance of Indian life insurance companies. Ishtiaq & Siddiqui (2019) examined the determinants influencing the financial performance of Pakistan's life insurance sector. Their findings revealed that factors like tangibility, market share, net premium, insurance leverage, and GDP either had no significant impact or were negatively correlated with the financial performance of Pakistani life insurance companies. Conversely, variables such as liquidity, underwriting risk, debt-to-equity ratio, equity capital, capital surplus, and inflation were found to have a positive and significant relationship. Maseki et al. (2019) revealed that changes in risk perception, macroeconomic factors, and investment portfolio choices account for 74.9% of the financial performance of listed insurance companies in Kenya. Derbali & Jamel (2019) studied the determinants of performance of Tunisian insurance companies from 2002 to 2018 using the panel data method. The study's results concluded that the determinants of the performance of Tunisian insurance companies are capital structure, solvency, risk capital management, premium growth, capital volume, firm age, and financial investments. Sharma et al. (2020) focused on the determinants of financial performance for insurance companies in the UK, using financial strength ratings as a basis. The results showed that key factors such as profitability, liquidity, company size, and organizational structure significantly impact their financial performance. Ntwali et al. (2020) assessed the effects of claims management on financial performance of insurance companies. The result showed that there is a positive correlation between claims planning, claims control, and claims M & E on ROE. Khovrak (2020) focused on comparing the ability of insurance companies to use an ESG-driven approach to managing their sustainable development. The study systematizes the best practices of insurance companies for applying the ESG-driven approach to manage their sustainable development and highlights the need for insurance companies to improve their reporting and disclosure practices related to the development of the ESG-driven approach. D'yakonova et al. (2020) used different tools to increase the competitive advantages of an insurance company in the modern insurance market, ensuring its survival and sustainable development. Morara & Sibindi (2021) analyzed what affects the financial performance of insurance companies. They found that the size of an insurance company positively correlates with financial performance, suggesting that larger firms with more assets are generally more profitable. However, the company's age was found to have a negative effect on performance. Olarewaju & Msomi (2021) researched the impact of intellectual capital on financial performance using data collected from 56 general insurance companies from 2008 to 2019, resulting in 696 observations. Their findings showed a notable and direct association between lagged return on assets, intellectual capital, and the financial performance of insurance firms.

The application of fuzzy set theory extends to evaluating financial performance, ranking insurance firms, choosing life insurance options, identifying alternative insurance models, and determining risk levels in client assessments in the insurance industry. Doumpos et al.(2012) applied the PROMETHEE II method, a preference ranking approach, to evaluate insurance companies considering a variety of conflicting financial criteria. Subsequently, they employed regression analysis to investigate the effect of firm-specific and country-specific attributes on the overall performance measure obtained from the initial assessment. Alenjagh (2013) employed both ANP and PROMETHEE methods to assess and rank insurance companies' performance on the Tehran Stock Exchange using financial ratios. Chen & Lu (2014) introduced an evaluation framework that combines the fuzzy analytical hierarchy process with an enhanced version of the fuzzy modified TOPSIS technique to determine the efficiency scores of insurance companies. Saeedpoor et al. (2015) used Fuzzy AHP to determine the weight of each SERVQUAL criterion, after which Fuzzy TOPSIS was employed to rank the insurance companies holding the largest market share in Iran's life insurance industry. Ksenija et al. (2017) introduced a fuzzy multi-criteria model designed to assess the efficiency of insurance companies. Initially, the FAHP method was used to establish priority weights for the criteria, and then the TOPSIS method was employed to rank the insurance firms. Hinduja & Pandey (2018) suggested an intuitionistic Fuzzy AHP model for insurance products. The proposed system has been tested by distinguishing insurance officials and experts, and an empirical study to check the accuracy of the proposed system found the results to be 91% accurate. Ansari et al. (2020) used fuzzy AHP with seven criteria to evaluate and select among basic insurance models, including conventional private insurance, mutual, and social insurance. Beiragh et al. (2020) suggested an integrated approach combining the Analytic Hierarchy Process (AHP) and Principal Component Analysis (PCA) for ranking insurance companies, assessing fourteen firms based on eight economic, three environmental, and four social indices. Pattnaik et al. (2021) highlighted that choosing the optimal insurance company to purchase an online term plan is complex. People often struggle to select the best insurance provider for online term plans. The authors utilized fuzzy TOPSIS to rank various insurance companies based on their online term plans. Mimović et al. (2021) pointed out that corporate and organizational performance assessment is an essential activity for both the managers and other stakeholders, as it provides them with an asset to evaluate their strengths and weaknesses in relation to the competition, as well as guidelines for selecting appropriate measures to address the existing problems. The authors combined TOPSIS and interval fuzzy rough sets to evaluate and rank the insurance companies. Lukić et al. (2022) employed fuzzy AHP and fuzzy IF-THEN rules to determine the risk level associated with contract extensions for existing policyholders, impacting business effectiveness and long-term sustainability of insurance firms. Erdemir & Krrkagac (2022) combined the analytical hierarchy process with grey relational analysis to compare the financial performance of non-life insurance companies in Turkey between 2014-2018. Işık et al. (2024) assessed the performance of non-life insurance firms in the Turkish market using a hybrid model comprising Pythagorean Fuzzy Analytic Hierarchy Process (PFAHP) and Multi-Attributive Ideal-Real Comparative Analysis (MAIRCA).

3. Methods

Based on the literature review, numerous studies have used regression and other models to evaluate the financial performance of insurance companies. Fuzzy theory has been applied to rank insurance companies, select life insurance products, identify alternative insurance models, and determine risk levels in client analysis within the insurance sector. However, there is a lack of research on determining criteria weights for financial performance regarding sustainable development using fuzzy AHP for insurance companies. This study introduces a fuzzy AHP method to address this research gap.

4. Results

4.1. Determine criteria

Financial performance is analyzed for numerous purposes, including returns, productivity, production, and economic growth. It can be adapted for businesses and related industries through financial ratios in the performance evaluation process (Türegün, 2022). This paper emphasizes that users can summarize and analyze these ratios to provide significant information for decision-making. They show the financial parameters that highlight the strengths and weaknesses of businesses in terms of liquidity, growth, and profitability. There are many financial ratios for evaluating performance; however, this research concentrates on the most relevant ones for presenting the health of insurance companies regarding sustainable development: current ratio, solvency ratio, loss ratio, premium retention ratio, premium growth rate, and sale profitability ratio.

Current ratio (C_1)

Liquidity is the capability of an insurer to pay liabilities, which include operating expenses and payment for losses/benefits under insurance policies. Liquidity ratios are used to measure a company's ability to pay liabilities. The Current ratio, one of the frequently used liquidity ratios, is calculated by dividing the current assets into short-term liabilities. Because the liquidity risk will decrease due to the increase in the current ratio, there is expected to be a reverse relationship between the current ratio and the profitability of non-life insurance companies (Kaya, 2015).

Solvency ratio (C_2)

Solvency measurement is an important measure that assesses companies' capital adequacy in terms of quality and quantity, and it is essential, particularly for the insurance sector. The solvency ratio obtained by dividing available equity capital by required equity capital should be higher than 1 for sustainability, which is the reason behind the regulation that the minimum solvency ratio of any life insurance company should be 1.5 (Suvvari et al., 2019).

Loss ratio (C_3)

This ratio is one of the most critical performance criteria for insurance companies. The loss ratio, which is also expressed as the underwriting risk in the relevant literature, demonstrates the effectiveness of the underwriting activities of insurance companies. This study calculates the loss ratio by dividing the incurred claims by the earned premiums. In general, all insurance companies propose that their premiums increase and that the claims they are required to compensate decrease. Accordingly, the expected effect of the loss ratio on profitability is negative (Kaya, 2015).

Premium retention ratio (C_4)

The insurance provided to insurance companies is expressed as reinsurance. Risks that are transferred to insurance companies from individuals and enterprises could be transferred to reinsurers from insurance companies through reinsurance. Reinsurance allows insurance companies to mitigate the impact of unexpected major losses, ensure the stability of earnings, and increase underwriting capacities. However, reinsurance also has a cost. For this reason, insurance companies are required to determine an appropriate retention level and establish a balance between decreasing insolvency risk and reducing potential profitability (Kaya, 2015).

Premium growth rate (C_5)

Gross written premiums are the main income insurance companies earn from insurance activities. The increase in premium growth rate will ensure the growth of the company and increase its market share. On the other hand, excessive or poorly coordinated growth of premium volume causes or aggravates other risks that may endanger the company's existence (Kaya, 2015).

Sale profitability ratio (C_6)

The sales profitability ratio measures profitability compared to gross written premiums. This ratio associates net income before taxes with gross written premiums and is calculated by dividing net income before taxes by gross written premiums. Insurers desire the high ratios regarding technical profitability and sales profitability (Kaya, 2016).

4.2. Fuzzy AHP

In this work, trapezoidal fuzzy numbers are used. Fuzzy number A is a trapezoidal fuzzy number, denoted by (a,b,c,d), if its membership function f_A is given by

$$f_A(x)=\begin{cases}(x-a)/(b-a), & a\le x\le b,\\ 1, & b\le x\le c,\\ (x-d)/(c-d), & c\le x\le d,\\ 0, & \text{otherwise.}\end{cases} \tag{1}$$

The fuzzy AHP method from (Kahraman et al., 2015) is used herein to evaluate the weights of criteria.

Step 1. Set up linguistic value matrix

In this initial step, experts ($t,\ t=1\sim k$) express their assessment of the importance of criteria by linguistic value using pairwise comparison. Afterward, based on these judgments, build a positive reciprocal comparison matrix of criteria weights given as:

$$\tilde{C}= \begin{array}{c} 1 \\ 2 \\ \vdots \\ \vdots \\ i \\ \vdots \\ \vdots \\ n \end{array} \begin{bmatrix} \tilde{c}_{11} & \tilde{c}_{12} & \cdots & \tilde{c}_{1j} & \cdots & \tilde{c}_{1n} \\ \tilde{c}_{21} & \tilde{c}_{22} & \cdots & \tilde{c}_{2j} & \cdots & \tilde{c}_{2n} \\ \vdots & & & & \vdots & \vdots \\ \vdots & & & & \vdots & \vdots \\ \tilde{c}_{i1} & \tilde{c}_{i2} & \cdots & \tilde{c}_{ij} & \cdots & \tilde{c}_{in} \\ \vdots & \vdots & & & \vdots & \vdots \\ \vdots & \vdots & & & \vdots & \vdots \\ \tilde{c}_{n1} & \tilde{c}_{n2} & \cdots & \tilde{c}_{nj} & \cdots & \tilde{c}_{nn} \end{bmatrix} \tag{2}$$

Step 2. Aggregate individuals' preferences into a group preference

These linguistic values are converted into trapezoidal fuzzy numbers. Subsequently, the fuzzy trapezoidal averaging method is applied to aggregate experts' individual judgments as follows.

$$\tilde{C}_{ij} = \frac{1}{k}\left[\tilde{C}_{ij}^{1}(+)\tilde{C}_{ij}^{2}(+)...(+)\tilde{C}_{ij}^{t}(+)...(+)\tilde{C}_{ij}^{k}\right] \tag{3}$$

where k is the number of experts and $\tilde{C}_{ij}^{t}$ is the evaluation of the t decision maker for criterion i versus j in the pairwise comparison matrix.

Step 3: Obtain the fuzzy weights of the fuzzy positive reciprocal matrix

This step obtains fuzzy weights by applying the geometric mean method, which was initially introduced by Buckley (1985) as Eq. (4). This method is used because it is easy to extend to the fuzzy case and guarantees a unique solution to the reciprocal comparison matrix (Kahraman et al., 2015).

$$a_i = \left[\prod_{j=1}^{n} a_{ij}\right]^{1/n} \text{ and } a = \sum_{i=1}^{n} a_i \tag{4}$$

Similarly, b_j and b, c_j and c, d_j and d can be defined. The fuzzy weight $\tilde{w}_j$ is determined as:

$$\tilde{w}_i = \left(\frac{a_i}{d}, \frac{b_i}{c}, \frac{c_i}{b}, \frac{d_i}{a}\right), \ \forall i \tag{5}$$

Step 4: Defuzzify the weights of the criteria

Proper defuzzification is necessary to convert the trapezoidal fuzzy number scales into matching crisp values. The matching crisp value can be obtained by equation 6:

$$w'_i = \frac{\frac{a_i}{d} + 2\left(\frac{b_i}{c} + \frac{c_i}{b}\right) + \frac{d_i}{a}}{6} \tag{6}$$

Step 5: Normalize the crisp weights

The final criteria weights can be achieved by using Eq. (7) as the following equation. A larger weight indicates a higher importance of the corresponding criterion.

$$w_i = \frac{w_i^{'}}{\sum_{i=1}^{n} w_i^{'}}, \ i = 1 \sim n. \qquad (7)$$

4.3. Numerical example

Consider a committee of three decision-makers (D_1, D_2, D_3) tasked with evaluating criteria for investors to choose insurance companies. They use six criteria: current ratio (C_1), solvency ratio (C_2), loss ratio (C_3), premium retention ratio (C_4), premium growth rate (C_5), and sale profitability ratio (C_6). The committee uses linguistic terms and corresponding trapezoidal fuzzy numbers, as listed in Table 1. The linguistic values assigned by the decision-makers in the pairwise comparison matrix are depicted in

Table 2 and converted to trapezoidal fuzzy numbers, as shown in Table 3. Using Eq. (4), the geometric mean of each row is calculated and presented in Table 4. The final weights are then determined using Eqs. (5)-(6) and displayed in Table 5.

Table 1: Linguistic terms for the importance weights of the criteria

Linguistic terms	Trapezoidal fuzzy number
j is as equally important as k (EI)	(1, 1, 1, 1)
j is weakly more important than k (WI)	(1, 3/2, 2, 5/2)
j is slightly more important than k (SI)	(3/2, 2, 5/2, 3)
j is moderately more important than k (MI)	(2, 5/2, 3, 7/2)
j is fairly more important than k (FI)	(5/2, 3, 7/2, 4)
j is obviously more important than k (OI)	(3, 7/2, 4, 9/2)
j is strongly more important than k (SMI)	(7/2, 4, 9/2, 5)
j is exceptionally more important than k (EMI)	(4, 9/2, 5, 11/2)
j is absolutely more important than k (AMI)	(9/2, 5, 11/2, 6)

Source: Authors

Table 2: Linguistic values matrix

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	EI	SI	1/MI	1/OI	1/WI	1/OI
C_2	1/SI	EI	1/OI	1/EMI	1/MI	1/SMI
C_3	MI	OI	EI	1/MI	FI	1/EMI
C_4	OI	EMI	MI	EI	OI	1/SI
C_5	WI	MI	1/FI	1/OI	EI	1/FI
C_6	OI	SMI	EMI	SI	FI	EI

Source: Authors

Table 3: Trapezoidal fuzzy number

	C_1				C_2				C_3				C_4				C_5				C_6			
C_1	1/1	1/1	1/1	1/1	3/2	2/1	5/2	3/1	2/7	1/3	2/5	1/2	2/9	1/4	2/7	1/3	2/5	1/2	2/3	1/1	2/9	1/4	2/7	1/3
C_2	1/3	2/5	1/2	2/3	1/1	1/1	1/1	1/1	2/9	1/4	2/7	1/3	2/11	1/5	2/9	1/4	2/7	1/3	2/5	1/2	1/5	2/9	1/4	2/7
C_3	2/1	5/2	3/1	7/2	3/1	7/2	4/1	9/2	1/1	1/1	1/1	1/1	2/7	1/3	2/5	1/2	5/2	3/1	7/2	4/1	2/11	1/5	2/9	1/4
C_4	3/1	7/2	4/1	9/2	4/1	9/2	5/1	11/2	2/1	5/2	3/1	7/2	1/1	1/1	1/1	1/1	3/1	7/2	4/1	9/2	1/3	2/5	1/2	2/3
C_5	1/1	3/2	2/1	5/2	2/1	5/2	3/1	7/2	1/4	2/7	1/3	2/5	2/9	1/4	2/7	1/3	1/1	1/1	1/1	1/1	1/4	2/7	1/3	2/5
C_6	3/1	7/2	4/1	9/2	7/2	4/1	9/2	5/1	4/1	9/2	5/1	11/2	3/2	2/1	5/2	3/1	5/2	3/1	7/2	4/1	1/1	1/1	1/1	1/1

Source: Authors

Table 4: Geometric mean of each row

	a	*b*	*c*	*d*
a_{j1}	0.451	0.525	0.616	0.742
a_{j2}	0.303	0.338	0.383	0.447

a_{j3}	0.959	1.098	1.246	1.411
a_{j4}	1.698	1.951	2.221	2.526
a_{j5}	0.550	0.652	0.759	0.881
a_{j6}	2.324	2.689	3.039	3.378
Sum	6.286	7.251	8.263	9.384

Source: Authors

Table 5: Criteria weights

Criteria	C_1	C_2	C_3	C_4	C_5	C_6
Weight	0.07	0.05	0.15	0.27	0.09	0.37

Source: Authors

Table 5 calculates the final criteria weights to assist potential investors in evaluating financial performance of different insurance companies regarding sustainable development. According to this result, the sale profitability ratio is the most important criterion for 0.37. The premium retention ratio is ranked second at 0.27. The third and fourth are related to the loss ratio, and premium growth rates are 0.15 and 0.09, respectively. The current ratio is ranked fifth, and the least important criterion is the solvency ratio. The weight distribution prioritizes the criteria, with the sale profitability ratio and premium retention ratio being the dominant factors. The relatively low weights of the current ratio and solvency ratio imply that while these criteria are considered, they are not central to the research's conclusions or recommendations. The loss ratio and the premium growth rate fall in the mid-range, with the loss ratio being moderately important and the premium growth rate slightly less. To summarize, the ranking order of criteria is sale profitability ratio (C_6) > premium retention ratio (C_4) > loss ratio (C_3) > premium growth rate (C_5)> current ratio (C_1) > solvency ratio (C_2).

5. Conclusion

The financial performance of insurance companies has direct implications on a wide section of the public, from policyholders to shareholders, company employees to intermediaries, and regulatory authorities to potential investors. For determining the financial performance, financial ratios like current ratio, solvency ratio, return on asset ratio, and leverage ratio are calculated for each life insurer, taking into consideration liquidity, solvency, profitability, and leverage of the company. A single factor cannot reflect every aspect of a company's performance; therefore, using several factors allows a better evaluation of the financial profile of firms. Due to its importance, a comprehensive method should be employed to measure insurance companies' financial performance and identify the factors influencing their performance. Multi-criteria techniques can be beneficial in evaluating whether firms are performing better or worse than their competitors. Their main advantage is that they summarize performance in a single score that simultaneously assesses firm differences in a multidimensional framework. This study proposes a fuzzy AHP method to evaluate the criteria weights for selecting insurance companies based on financial performance.

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Developing Green Finance System - International Experiences and Policy Implications for Vietnam

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Abstract

In the context of the current ecological crisis, many countries have been transforming from the traditional economic model to an environmentally friendly economy - the green economy. The green financial system plays an important role in moving towards a green economic ecosystem. The study analyzes the development of green finance in the world and assesses the current status of green system development in our country, thereby drawing some policy implications for Vietnam to develop a green financial system, promoting the transition to a green economy in Vietnam.

Keywords: *Green economy, green index, green finance, international, China, UK, Vietnam*

1. Introduction

Vietnam used to be a "green" country in the 20th century, but with recent socio-economic growth, our country has become the leader in Southeast Asia in terms of greenhouse gas emissions. The economic development process in Vietnam in recent times has depended on resource exploitation, export of raw materials and preliminary processing, causing damage to the environment and increasing the impact of climate change. It can be seen that, in contrast to the green economy - an economy that ensures 3 factors: economic growth, social equity and environmental protection, Vietnam's current economic development model is still in a "brown" state, meaning that the economy focuses on exploiting and using too much energy from raw fuels, affecting the environment. Like many countries in the world, Vietnam is making efforts to transform the economy from "brown" to "green" through many programs and actions. However, to actually do that is a very difficult problem, requiring the cooperation and consensus of the whole society.

A few years ago, the concept of green finance was quite new to our country's economy. However, with the context of climate change happening globally, as one of the countries with the highest pollution levels today, Vietnam is increasingly concerned about this issue. This is considered an important solution, contributing to the process of developing a sustainable economy.

2. Methods

In order to achieve the research goal, the paper uses a desk research method. Specifically, this study searches for relevant sources such as journals, books, and journal articles through the digital library Science Direct, Google Scholar, and university libraries, which provide authoritative and reliable academic sources. The search keywords are terms related to the research topic such as “green finance”, “green finance”, “green index”, China, Vietnam, and synonyms. The time range of the source search focuses on the past 15 years to ensure timeliness. In addition, Google search engine was used to search for online news, industry reports, and conferences related to the topic of the research paper.

3. Results

3.1. Overview of green finance

3.1.1. Green finance definition

“Green economy” is an economy that improves human life and social equity, while significantly reducing environmental risks and ecological deficiencies. Simply put, a green economy has low emissions, uses resources efficiently and aims for social equity. Currently, according to Nannette's research (2014), there is no specific concept of green finance and green finance is still understood in many different approaches. However, in this article, the author uses the concept of a green financial system according to the state-level research group (KX01.27/16-20).

Accordingly, the green financial system is understood as: “A financial system that allows the circulation of financial resources to investment activities through financial intermediaries and financial markets in which investment activities must ensure green conditions, protect the environment and aim for sustainable development. At that time, the components of the green financial system will have green characteristics, including: green financial intermediaries, green financial markets, green capital mobilization tools or green capital sources, and green investment”.

Figure 1: Components of Green Finance

Source: Lindenberg, April 2014

3.1.2. The role of green finance in the economy

The green financial system plays the role of a capital channel and resource regulator for the development of the green economy (regulating investment activities). The green financial system promotes green instruments such as green credit of green banks, green bonds, green stocks, green financial indexes. In addition, the green financial system also helps promote various types of green markets.

Based on the core role of the green financial system in contributing to the green economy, research results from countries and territories such as Europe, the US, South Africa, Korea and China show that the greening of the financial system is of interest to many countries in the world in order to overcome and limit the negative impacts of economic development on the environment, and improve the environment through greening the economy. The initial research results are an important scientific basis for developing a green financial development model suitable for the conditions of each country and each economy. Although this is a relatively new field, recognizing the important role of developing a green financial system, Vietnam has initially aimed to develop a green financial system towards sustainable development. However, up to now, green financial policies in Vietnam are only in the form of suggestions for development orientations. Specific regulations on market implementation and operation are still being studied and have not been issued, including the development of a set of indicators to assess the level of greening of the financial system.

This study will focus on assessing the current status of green system development in Vietnam, thereby proposing the development of a set of indicators to help position the green financial system, and at the same time making some recommendations to the subjects participating in the green financial system to realize the long-term goal. Contributing to the development of a set of indicators to assess the greening level of the financial system in particular and the economy in general will make a great contribution to theoretical and academic science for economic and financial research in Vietnam as well as the world.

3.1.3. Green Finance Index

In the world, there have been a number of studies proposing the construction of a set of green economic indicators such as the study of Danlu (2018) applied to the Chinese market proposed the model of the Green Economic Development Index (GEI). In which, this index will have a functional relationship with variables such as: Renewable Energy Investment (INV), Green Credit (CRE), Pollution Treatment Investment (IPG), Technical Level (TE), and Sector Structure. The study of Puhakka (2017) also gave similar results to the study of Danlu (2018) when it stated that the factor of government policies and regulations is an important factor affecting the transformation into a green economy.

Anton (2016) built a set of green economic indicators (GEI) consisting of 26 indicators. These indicators cover key issues such as: (1) National governance; (2) Ratio of fossil fuel financing/investment in environmental/renewable energy/environmental patents to total GDP; (3) Organic farm area to total agricultural land area; (4) Share of renewable energy in total primary energy supply; (5) Ecological footprint (excluding carbon emissions); (6) Average energy consumption/Average water withdrawals/Emissions/Average emissions treatment/Greenhouse gas emissions per capita; (7) Domestic raw material consumption; (8) Air/water pollution index; (9) Ratio of marine and terrestrial protected areas; (10) Ratio of threatened species; (11) Ratio of land conversion; (12) Poverty gap; (13) Basic needs index, (14) Adjusted net savings (real savings) as a percentage of gross national income; (15) Human Development Index; (16) Employment to working-age population ratio; (17) Decent work index; (18) Gini coefficient; (19) Life satisfaction… Thus, it can be seen that the proposed GEI index is very comprehensive, reflecting many impactful contents and needs to be considered when moving towards a green economy. The survey results show that Switzerland, Austria and Sweden are the three countries with the highest rankings, and Kazakhstan, Yemen and Turkmenistan have the lowest ranks. However, surprisingly, the United States ranks in the 15 countries with the lowest GEI scores out of the total sample of 193 countries. It should also be emphasized that, similar to most other studies, national governance is a key factor influencing this group of indicators.

However, when going deeper into green finance - a content of green economy, the number of studies on constructing green finance index is still limited. Shah (2016) developed a financial friendliness index based on factor analysis and nonlinear weighting to compare the level of financial risk sharing and support between countries. Zhang et al. (2018) formed a financial development index through econometric analysis and showed that in the short term, Pakistan's financial development index and energy prices are significantly related to energy consumption. Zhong et al. (2018) divided the green financial development index system into two types: green financial market performance index and green financial ecological environment index, and then constructed a green financial development index. The research team of the Wuxi Central Branch of the People's Bank of China (2019) evaluated the sustainability of green financial development from three aspects of green finance, green investment and green society, and measured and evaluated the comprehensive level of green financial sustainable development in China by constructing a comprehensive evaluation system for the sustainable development of green materials. Wang (2021) constructed a green finance index based on the evaluation of projects in China, including: (1) Green agricultural development projects, (2) Green forestry development projects, (3) Energy-saving, water-saving industrial projects for environmental protection, (5) Nature protection, ecological restoration and disaster prevention, (6) Resource recycling projects, (7) Renewable energy and clean energy projects, (8) Rural and urban water saving projects, (9) Construction of energy-saving projects and green buildings, (10) Green transportation projects, (11) Energy-saving and environmental protection service projects, (12) Foreign projects applying international practices or international standards, (13) Energy saving and environmental protection, (14) New energy and new energy vehicles.

There are several sets of indicators used for the green economy system in the world, such as: (i) The Global Green Finance Index (GGFI) was jointly developed by Z/Yen as part of the Long Finance Initiative and the NGO Finance Watch, (ii) The Global Green Economy Index (GGEI) was the first green economy index launched in 2010 and is currently the most widely referenced product in the world today. The GGEI is widely used by policy makers, international organizations, civil society and the private sector. The GGEI measures the green economic performance of 130 countries and how experts evaluate that performance. The GGEI Performance Index uses quantitative and qualitative indicators to measure how each country is performing across four key dimensions: leadership and climate change, performance sectors, markets and investment, and finally the environment, (iii) UNEP's Measuring Progress towards a Green Economy, (iv) S&P Global Green Evaluations.

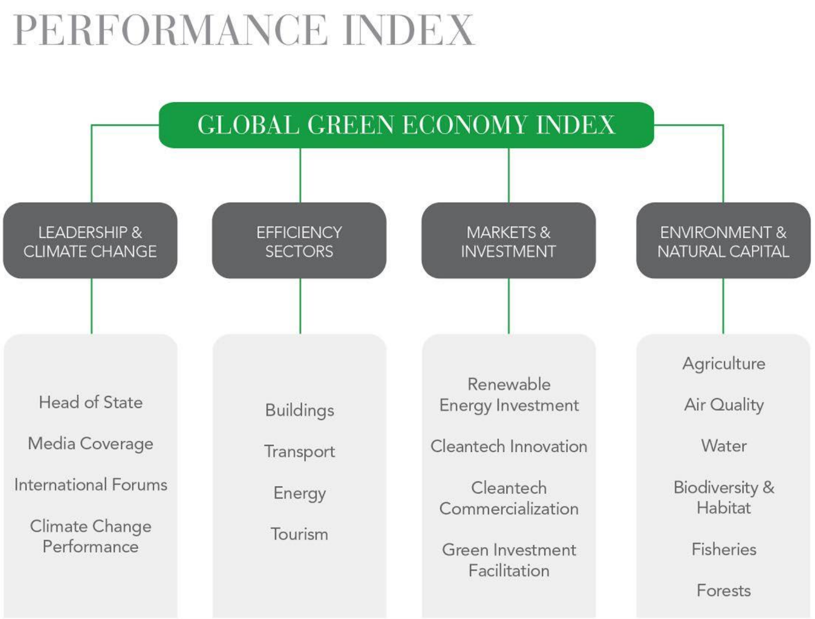

Figure 2: Global Green Economy Index

Source: GGEI 2016

Thus, it can be seen that although each country has its own characteristics, which will affect the construction of different sets of indicators, it is important to emphasize that some common indicators such as national governance, water consumption/emissions... will be used as tools to assess the level of access to green finance as well as green economy.

3.2. Experience in developing green finance worldwide

Green financial development in the world is carried out in very different ways. These methods depend on the economic conditions as well as the financial market characteristics of each country, but all leave useful lessons for countries that follow, such as Vietnam. Experience in developing green financial systems in the world can be divided into two main groups. One is the group that develops green financial systems focusing on the Government and large financial institutions. The other is the group that develops green financial systems focusing on microfinance institutions. In this article, three typical cases are the UK - a country with a high level of development, China - a country with outstanding growth in recent times and the Philippines - a country with many similar characteristics to Vietnam are studied.

3.2.1. Experience in the United Kingdom

The UK Government plays an active and proactive role in establishing green financial markets. The commitment to deploying a green financial system is included in the overall development strategy of the economy as well as the Government directly participates in the process of mobilizing green capital.

First of all, the Government builds a simple, stable and easy-to-apply green financial system development policy framework as well as regularly conducts timely reviews, assessments and adjustments. In order to attract capital from institutional and private investors to green the economy, the UK Government has launched a series of initiatives aimed at removing barriers to green investment through simplifying procedures, supporting risk management, developing skills and experience in green projects. The Government also regularly evaluates the transition to a green economic model to draw necessary and timely adjustments. Therefore, the Government has created a favorable investment environment with low risks for investors, thereby effectively attracting green capital from domestic and foreign investors.

In the next stage, the UK Government directly invested seed capital in the green economic sector to promote implementation in practice. Specifically: (i) building a direct funding mechanism for green investment projects, (ii) implementing government guarantees for green infrastructure projects as well as participating in funding for environmental protection funds. From there, forming and ensuring funding sources for green industries and sustainable growth. Although the amount of investment from the Government only accounts for a small proportion, it plays an extremely important role in promoting private sector activities. According to UNESCAP's assessment, a government investment of 10 billion USD for climate change can call for about 50 - 150 billion USD from the private sector. Finally, the Green Investment Bank was established to support investment in green infrastructure projects that the market cannot finance. The bank's main investment areas include renewable energy, transport, waste treatment and water resources... Through the establishment and operation of the Green Investment Bank, the British Government has encouraged private capital for green projects to increase the country's transition to a green economy. Specifically, the Green Investment Bank has attracted about 18 billion pounds of private investment in the fiscal year 2015 - 2016.

The above activities of the Government can reduce uncertainty and risk, increase the assurance of expected profits from the project, which will increase the ability to convince private investors. Thereby, creating conditions for the strong development of the green financial market and spreading the impact of green projects to the entire economy.

3.2.2. Experience in China

China needs about 320 billion USD in green investment each year to protect its environment. However, the state budget can only meet 15% of the demand (According to calculations by the People's Bank of China - PBoC). Therefore, in April 2015, the Greening of the Financial Market Program was launched to meet the needs of a green economy and sustainable development. The Greening of the Financial System Program focuses on the following key points: (1) forming a financial mechanism to encourage green investment; (2) building institutions specializing in green investment and lending activities; (3) providing green financing products and channels; (4) ensuring the effective use of public finance to encourage private financial flows; (5) forming an information infrastructure to support investors in assessing the environmental impact of investments, such as a green credit index system and environmental information disclosure regulations. For each focus in the Greening the Financial System Program, the Government provides a detailed implementation plan for each phase.

To promote the development of green bonds, on December 22, 2015, PBoC allowed financial institutions to issue “green bonds” in the interbank market to increase funding for “green” projects, supporting the transition to a green economy. In particular, the conditions for issuing green bonds are not complicated, the implementation procedures are short, thereby encouraging an increase in market size. Regulations on green bonds are quite flexible (right to buy back, interest rates according to the agreement of the parties...). The fields allowed for investment are diverse with 31 sub-fields in 6 main groups: (1) Energy saving; (2) Pollution Prevention and Control; (3) Resource Conservation and Recycling; (4) Clean Transportation; (5) Clean Energy; (6) Ecological Protection and Climate Change Adaptation.

As a result, China's green bond issuance volume has grown explosively from over 1 billion USD (2015) to 36 billion USD (2016). In the first 6 months of 2017 alone, China issued an additional 11.52 billion USD, accounting for more than 20% of global green bonds. By the end of the first quarter of 2019, China had become the largest green bond issuer in the world with a total scale of over 93 billion USD (accounting for 22% of the global market), of which 2/3 were green bonds issued by commercial banks.

3.2.3. Experience in the Philippines

The Philippines' experience in developing green finance is to make good use of support from international organizations such as IFC, World Bank (WB) ... and to form large banks that provide green financial products in the form of wholesale to other banks. Since then, commercial banks have contributed significantly to promoting green financial development in this country. Specifically: (i) DBP Bank is the focal point for implementing the Environmental Industrial Support Credit Program (EISCP) in collaboration with JICA; Sustainable Solid Waste Management Program in collaboration with the German Reconstruction Bank (KfW); The Rural Power Project (RPP) with the WB approved in 2003 under the global environmental protection program. (ii) BPI Bank implements the Sustainable Energy Finance Program (SEF) with the support of IFC. This program provides finance for investment projects in technology to increase efficiency in energy production, distribution and use.

The active participation of commercial banks partly comes from the significant benefits of participating in green finance projects. Specifically: (1) Access to rare long-term capital sources; (2) Interest rates are lower than market interest rates, commercial banks can provide customers with attractive products and attract new customers; (3) The reputation of commercial banks is significantly increased when cooperating with international organizations, at the same time this is a low-cost way of advertising in the media; (4) Banks will minimize the risk of default, especially in back-to-back credit guarantees or back-to-back collateral.

4. Discussion

4.1. Implications for green finance developing policies in Vietnam

In Vietnam, Resolution No. 52-NQ/TW was issued by the Central Party Committee on September 27, 2019 concerning the pro-active and positive participation in the Fourth Industrial Revolution. Before this, the Government had issued Directive No. 16/CT-TTg on enhancing the capacity to access the Fourth Industrial Revolution, serving as the foundation for various ministries, departments, and sectors to build an IT and digital technology infrastructure to ensure the safety and security of cyberspace and create equal and easy access for people and businesses to digital content opportunities. Commercial banks have also recognized the potential, challenges, and urgent need to meet the demand for building an open banking ecosystem.

The current status of green financial system development in Vietnam is assessed from two perspectives: (i) Green capital and (ii) Green investment.

Regarding green capital, Vietnamese enterprises can borrow capital through direct financial channels including: Carbon Market, Green Bond Market, Green Stock Market, Green Rating Index System, Green Investor Network. In addition, enterprises can access green financial capital through indirect financial channels such as green banks or green investment funds. Currently, commercial banks have also identified a high level of commitment to green issues in their investment strategies. In general, many organizations have committed to supporting green investment and implementing the goals of the National Green Growth Strategy. This is also reflected in the green credit ratio index of the entire banking sector, which increased by more than 2.5 times within 4 years from 1.5% in 2016 to 4.1% in 2019. The majority of funding sources for green finance in Vietnam currently come from the Government, national development organizations, international institutions or bilateral and multilateral development banks, businesses and individuals. In addition, the development of green capital from green credit has only begun to receive attention from a number of commercial banks. The two popular groups of green finance mobilization tools today are Green Bonds and Green Equity. However, up to now, in Vietnam, the main green finance mobilization tool is still used through the issuance of green bonds.

Regarding green investment, in Vietnam, large-scale enterprises have begun to pay more attention to environmental protection and social responsibility. Some typical enterprises in the green investment trend include: Vingroup, Vinamilk, Hoa Sen Group, Coca Cola Vietnam Company, COFICO Construction Joint Stock Company No. 1, Toyota Vietnam. In addition, at the macro level, the Government and the State Bank have issued many Directives to promote the development of green investment. On September 25, 2012, the Prime Minister issued Decision No. 1393/QD-TTg approving the national strategy on green growth for the period 2012-2020 and vision to 2050. Activities to attract resources for green investment have also been actively coordinated between international organizations, donors and Government agencies. The SBV also issued Directive No. 03/CT-NHNN dated 24/3/2015 on promoting green credit growth and managing environmental and social risks in credit granting activities. In addition, the Eco-Industrial Park initiative towards a sustainable industrial park model in Vietnam has been implemented by the Ministry of Planning and Investment and UNIDO since 2014. At the micro level - the enterprise level, the green startup wave has been growing stronger and stronger. Enterprises of sufficient scale have begun to pay more attention to environmental protection and social responsibility.

4.2. Policy implications

Based on the assessment of development experience in the world and the current status of green finance development in Vietnam, the article proposes some policy implications as follows:

Firstly, for the Government, it is necessary to make a strong commitment to implementing the country's General Development Strategy towards the transition to a green economic model. Specifically: (i) Establish strategic orientations for the formation of green industries and sustainable growth; (ii) Develop stable policies with clear commitments to support the process of forming green industries. At the same time, the Government also needs to implement measures to support attracting green finance for the economy through actions such as prioritizing adequate funding from the central and local budgets to implement the green growth strategy, especially improving energy efficiency and developing artificial energy; ensuring a minimum profit level to encourage businesses to invest in industries using green technology and producing green products; have policies to encourage the financial system to finance the development of green industries and sustainable growth, and develop new financial products to support a low-carbon economy.

Secondly, for the Ministry of Finance and the State Securities Commission, it is necessary to continue to perfect the orientation for developing the green capital market through completing the Project on issuing green government bonds and submitting it to the Government for approval to have a basis for widespread implementation; develop and implement support policies for the green capital market such as: fiscal policies such as taxes, fees as well as support guarantee mechanisms for green industries/sectors. In addition, the above agencies need to actively participate in cooperation with international financial organizations such as the WB, IFC, Asian Development Bank (ADB) and international green financial funds to take advantage of green development capital from these organizations.

Thirdly, for financial institutions and scientists, it is necessary to develop a set of green finance indexes for Vietnam. The Green Finance Index (GFI) is an index to assess the level of green finance development, proposed by research based on international experience and survey results, in-depth interviews with experts in the field of banking and finance in Vietnam. The Green Finance Index (GFI) is divided into 2 components: Green Banking (GBI); Green Securities (GSI). The Green Banking Index (GBI) is understood as the assessment of the level of response of each commercial bank in particular and the commercial banking system in general in Vietnam according to the scale from 1 to 5, corresponding to the levels of Kaeufer (2010). The measurement of the GBI Green Banking Index is proposed based on the research results of Tran Thi Thanh Tu et al. (2019). The proposed Green Securities Index (GSI) for Vietnam is understood as a green stock index and a green bond index. The proposal to build a green stock index is based on international experience in building green stock and green bond indices of countries with developed stock markets. From building a set of green financial indices, experts and scientists in the field of finance and banking will be able to position the green financial system in the economy, and at the same time, propose a specific roadmap for developing green finance until 2050.

5. Conclusion

Promoting a green economy towards sustainable growth and development is the path that Vietnam has chosen. In that process, green finance is an important solution. This is a new issue in Vietnam in both awareness and practice, with many opportunities and challenges ahead. Therefore, in the current period, there needs to be determination and participation of many sectors, many fields, many units for green finance to become a reality and have practical significance in the strategy of greening the Vietnamese economy.

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Green Credit for Sustainable Development in Vietnam

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Abstract

Promoting a green economy, in the context of sustainable development, is increasingly interested worldwide, and green credit development plays an indispensable role in the sustainable development strategy. In recent years, facing many environmental problems, Vietnam has been implementing a green growth strategy, in which banks play an important role in this strategy with green credit policies. Green credit activities have also been implemented in recent years and achieved many encouraging results in many fields, including energy saving, renewable energy, clean agriculture and high technology agriculture. Besides, the process of developing green credit still has many problems. Based on the analysis of the theoretical basis and the actual situation, the author makes a number of proposals to promote green credit towards sustainable development in Vietnam. This article addresses the current situation of green credit in Vietnam, thereby offering solutions to promote sustainable growth of green credit.

Keywords: *green credit, sustainable development, green economy.*

1. Introduction

The trend of green credit growth has been developing for a long time globally with energy saving, trenewable energy, and clean technology projects aiming at the dual goal of economic growth with environmental protection (Bos K. & Gupta J., 2019). Green credit is a necessary solution for people, organizations and businesses, helping to minimize the negative impacts of life and production processes on the environment and society, contributing to the sustainable development of economy (Chen et al., 2018). Meanwhile, on the bank's side, implementing the green credit program also helps the bank enhance financial stability and protect its brand image in the market.

The banking sector contributes significantly to the implementation of green growth as a tool to encourage financial investment in environmentally friendly projects. Therefore, the green credit model is considered a unique financial tool, with important implications in controlling the environmental protection behavior of businesses and preventing uncontrolled development of businesses. causing pollution and harm to the environment (Xu & Li, 2020; Zhang S. et al., 2022).

With the national strategy on green growth for the period 2011 - 2020 and vision to 2050 approved by the Prime Minister, the bank's green credit policies are an important solution to guide the economy towards green growth goals and ensure sustainable economic development. However, green credit in Vietnam is still quite new and has not been developed much. Therefore, it is really necessary to come up with solutions for developing green credit, contributing to the sustainable development of the banking system as well as the Vietnamese economy.

2. Theoretical framework

The Asian Development Bank (ADB) defines green credit as a series of policies, systematic arrangements and implementation by banks to provide loans or other financial instruments that promote conserve energy and reduce emissions. According to the Organization for Economic Cooperation and Development (OECD), green credit is understood as a financial source provided to projects to achieve economic growth, while reducing pollution and greenhouse gas emissions. Minimize waste and improve the efficiency of natural resource use.

Green credit is a credit strategy of banks that does not support businesses that pollute the environment. Green credit adjusts the long-term and short-term credit ratio structure for enterprises, thereby affecting the investment structure and investment efficiency of heavily polluting enterprises (Wang et al., 2019). In the process of granting green credit, banks take information related to the project and business applying for the loan as inspection standards in the lending process, then make a lending decision (Yao et al., 2021). In other words, green credit is understood as credits aimed at supporting investment projects that pose little or no risk to the environment, contributing to overall ecological protection. These are the manifestations of the financial system. main direction towards sustainable development.

Green credit activities for corporate customers are implemented by the bank by creating groups specializing in financing large-scale renewable energy and clean energy projects, with a debt portfolio committed to full financing set or a part for the project (Xie & Liu, 2019). Green credit activities can be loans with interest rates much lower than the market applied to customers buying homes using green energy. For commercial building projects with lower energy consumption (about 15 - 25%), reduced waste and less pollution than traditional buildings, the bank will design and supply Attractive loan agreements with green commercial building construction loan products (Chen, 2019).

In Vietnam, according to Article 149 of the Law on Environmental Protection 2020, effective from January 1, 2022, that regulate on green credit are as follows: Green credit is credit granted to the following investment projects: (i) Effective use of natural resources; (ii) Responding to climate change; (iii) Waste management; (iv) Treating pollution and improving environmental quality; (v) Restoration of natural ecosystems; (vi) Conservation of nature and biodiversity; (vii) Create other environmental benefits.

3. Methods

In this study, the author uses secondary data collected from domestic and foreign scientific articles, reports, legal documents, researches... related to green credit for sustainable development. Analytical and synthetic methods are employed to clarify the green credit concepts, as well as the reality of green credit associated with sustainable development. Not only based on the analysis of the theoretical basis and the actual situation, but also through the methodological approach, the study aimed to provide a comprehensive analysis of green credit, particularly in the green credit for sustainable development, and propose strategies to develop its positive impacts in Vietnam.

4. Results

4.1. The current situation of green credit in Vietnam

Along with the direction of the Party and State, agencies have issued many documents, policies and laws on green credit and green banking. On March 24, 2015, the Governor of the State Bank of Vietnam issued Directive No. 03/CT-NHNN on promoting green credit growth and managing environmental and social risks in credit granting activities. On August 6, 2015, the Governor of the State Bank of Vietnam signed Decision No. 1552/QD-NHNN promulgating the Banking Industry Action Plan to implement the National Strategy on Green Growth until 2020. Here is a guiding regulation for the entire green banking development process in Vietnam, ensuring appropriateness and active support for the green growth process of the entire economy, in which, methods To implement the greening of the Banking Industry has been fully introduced. Next, on August 7, 2018, the Governor of the State Bank of Vietnam issued Decision No. 1604/QD-NHNN approving the "Green Bank Development Project in Vietnam". Decision No. 34/QD-NHNN on promulgating the Banking Industry Action Program to implement the Vietnam Banking Industry Development Strategy to 2025, with a vision to 2030, approved by the State Bank on September 7. January 2019. On July 4, 2022, the Governor of the State Bank of Vietnam signed Decision No. 1124/QD-NHNN promulgating the State Bank's Action Plan to implement Resolution No. 54/NQ-CP dated December 12, 2022 of the Government; In particular, there are regulations on green credit and green banking to promote bank credit capital into low-carbon production and consumption industries...

The 2020 Environmental Protection Law also added clearer regulations on green credit. Accordingly, Article 149 of the Law on Environmental Protection 2020 recorded 07 investment projects granted green credit; Lending activities of credit institutions and foreign bank branches in Vietnam; authority to guide environmental risk management. In addition, Article 155, Article 156 of Decree No. 08/2022/ND-CP dated January 10, 2022 of the Government detailing a number of articles of the Law on Environmental Protection also stipulates incentive mechanisms granting green credit and roadmap for green credit implementation.

Figure 1: Proportion of green credit in total credit (%)

Source: Department of Credit for Economic Sectors, State Bank of Vietnam

Besides, green credit activities have achieved many remarkable results in recent times. According to data from the Credit Department of Economic Sectors (SBV), in the period 2017 - 2023, green credit balance has an average growth of more than 25%/year, higher than the average growth rate of general credit. economy. The green credit market has become the main capital channel for green investment projects in the recent period, increasing from VND 71,020 billion at the end of 2015 (accounting for 0.73% of total outstanding debt in the entire economy) to more than 440,000 billion VND by the end of 2021 (accounting for nearly 4.3% of the total outstanding debt of the entire economy) by the end of 2022 and reaching nearly 500,000 billion VND (accounting for about 4.32% of the total outstanding debt of the economy). By December 31, 2023, there were 47 credit institutions with outstanding green credit debt reaching VND 620,984 billion, an increase of 24% compared to the end of 2022, accounting for about 4.5% of the total outstanding debt of the entire economy. Green credit loans are mainly focused on green agriculture with a proportion of 40%, followed by renewable energy/clean energy with 30%, and sustainable water management in the region. urban areas account for 13%, sustainable forestry accounts for 11% and other small sectors account for 6%. Many important areas in environmental protection and response to climate change such as waste management, transportation and sustainable construction are still very limited.

Currently, 84 credit institutions have submitted reports on the results of implementing Decision No. 1552/QD-NHNN dated August 6, 2015 on the Action Plan of the banking sector to implement the National Strategy on Green Growth. By 2020, representing over 80% of outstanding loans of the banking system. However, only 67/84 credit institutions have implemented relevant content on green banking and green credit development, on the basis of integrating regulations and administrative documents in banking activities row. Some commercial banks (commercial banks) in Vietnam have a high proportion of green credit such as: Agribank, BIDV, Sacombank, TPBank, Vietinbank, VPBank, Nam A Bank, HD Bank, etc.

The goal is that by 2025, 100% of credit institutions will participate in green credit granting activities. In particular, banks must have internal instructions and regulations to conduct social and environmental risk assessments according to regulations. The green credit growth rate is expected to reach 30-35% by the end of 2025, corresponding to the above rate, which is the target of the proportion of green credit in the economy from 4.5% to 10% by the end of 2025.

4.2. Challenges of development of green credit in Vietnam

Green credit activities in Vietnam have recently encountered a number of challenges such as:

Incomplete legal and policy framework. The legal and regulatory system related to green credit is lacking, not synchronized and not specific. This leads to inadequate evaluation and classification of green projects, lacking clear criteria to identify green projects. In addition, preferential policies and direct support for credit institutions and businesses participating in green credit are limited, hindering the development of this field.

The capacity of credit institutions is limited. Many banks do not have a team of professional green credit staff, leading to weak risk assessment and green credit management capabilities. The information technology system does not effectively support the implementation of green credit, making this activity difficult. Furthermore, administrative procedures are quite cumbersome and complicated, green credit lending interest rates are quite high, and there is a lack of organizations to support and advise businesses in implementing green credit. These are obstacles that need to be resolved quickly, paving the way for the green credit development process to become smoother and easier.

The green credit market is still young. Many businesses do not clearly understand green credit and its benefits, leading to limited ability to access and meet banks' requirements. Lack of green projects with high potential and economic efficiency, affecting the supply for the green credit market. Capital sources for green credit are limited, the secondary market for green loans is not yet developed. Lack of information and communication channels about green credit makes market access difficult.

Low awareness of environmental protection. For borrowers, many businesses and people do not really care about environmental protection. They only focus on immediate profits but ignore the negative environmental impacts of production and business activities. This leads to them not being interested in green credit products, whether they have preferential interest rates or support from policies. For lenders, banks are also hesitant about pouring capital into green projects because they are concerned about risks. Businesses that borrow green capital are often small in scale and lack experience and management capacity, making the project prone to failure. Furthermore, evaluating the efficiency and environmental impact of green projects is also difficult, making it difficult for banks to control risks.

5. Recommendations

Recommendations to promote green credit for sustainable development in Vietnam includes ones for the Government and State Bank and commercial banks and credit institutions.

For the Government and State Bank

Firstly, continuing to build and improve specific legal frameworks on green credit as well as business investment projects that affect the environment, the State Bank needs to introduce green credit standards and a list of green industries/fields for common and consistent application. This is the basis for commercial banks to rely on appraisal, evaluation and supervision when granting green credit packages. In addition, the State Bank needs to continue to research and complete the Manual on assessing social and environmental risks in credit granting activities of credit institutions.

Second, introduce preferential policies for commercial banks implementing green credit such as reducing the required reserve ratio for bank capital mobilized for project loans, refinancing incentives, and rediscounting. For green credit purposes in accordance with monetary policy objectives and measures, these loans are given priority in terms of term and loan capital compared to other fields.

Third, issuing green bonds creates capital for green credit. Currently, green bonds still only account for a small proportion of the global bond market, so the growth potential of green bonds is still very large. However, it is necessary to determine the amount of capital to be mobilized, the mobilization time, and the appropriate interest rate when issuing green bonds to meet green credit needs.

For commercial banks and credit institutions

Firstly, separate policies for green credit activities associated with green goals, including renewable energy, energy saving, and clean water sanitation, should be developed after the SBV promulgates a system of documents and regulations to increase the efficiency of this activity.

Second, promote the development of green credit products and rationally use capital from banks or State project programs for "green" projects to minimize negative impacts on the environment. In addition, commercial banks also need to develop modern banking services to minimize cash circulation in the market, contributing to the development of green credit products and Improving financial capacity by mobilizing resources from international financial institutions or foreign donors.

Third, organize, train, and strengthen the capacity of credit institutions and individuals participating in building and implementing policy mechanisms for green credit products to improve the capacity of the entire bank in the implementation of green credit.

Fourth, raise awareness of all people, agencies and organizations about the importance and role of green growth; Raise people's awareness in using, saving energy and protecting the environment. At the same time, bank staff must also be regularly trained to improve their understanding of green credit, thereby being able to better support customers.

Fifth, promote communication work by propagating green credit at seminars and conferences to reach more customers. From there, provide information for customers to grasp and better understand green credit as well as the benefits of green credit. Many customers interested in green credit will promote green credit development in Vietnam.

In addition, it is impossible not to mention the socio-economic environmental factors. In particular, the development of green economy will promote green credit growth. This is the intrinsic motivating factor in bank credit activities, through the relationship: bank - customer and the economy. Accordingly, having green, effective projects and plans that meet credit conditions and principles will facilitate access to bank credit capital, while creating conditions to promote the expansion and growth of green credit. Under current conditions, green economic development will be a favorable economic environment to promote green credit growth in Vietnam.

6. Conclusion

Green credit is an inevitable direction for the global financial industry in general and the banking industry in Vietnam in particular to expand production, apply advanced technology, improve productivity, and meet demand. consumption in the domestic market as well as increasing export market share to the world market. Besides, green credit plays a major role in promoting the process of social division of labor and economic cooperation domestically and internationally. Green credit policies also contribute positively to harmonious development and balance between the economy and the environment, minimizing negative impacts of production and business activities. In addition, thanks to the bank's green credit capital, production enterprises associated with environmental protection have the opportunity to supplement temporary capital shortages or expand capital sources to ensure normal production processes. Implementing the green credit program also helps banks reduce bad debts, enhance financial stability and protect brand image in the market, and enforce direct investment control activities of banking access to businesses.

Green credit in Vietnam is expected to have strong growth in the coming time. This is not only an opportunity but also a challenge for both businesses and banks. For businesses, green credit requires strict requirements from banks to qualify for funding. Meanwhile, banks consider it is both to be an important capital supply channel in the economy and to play the role of greening investment capital flows through directing financial resources into green field. It also limits capital flows into projects that affect the environment, actively promote green growth and sustainable development. All aim at a stable macroeconomy.

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Complete Tax Policy and State Budget Spending Policies to Support Green Agriculture in Vietnam

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Abstract

Vietnam's agriculture sector is making many efforts towards green agriculture through the application of financial tools, especially tax policies and state budget spending policies. These policies need to be combined at the same time to effectively promote green agriculture. This article analyzes and evaluates tax policies and state budget expenditure policies to support green agricultural development in Vietnam. The content of the regulations in tax policies is not yet detailed. Criteria related to green agriculture are not clear. the proportion of agricultural enterprises enjoying tax incentives is still low. State budget spending policies for high-tech applications in agriculture are still incomplete and synchronous. There is also a lack of consistency and unity between planning and budget execution. The research implies that there must be separate regulations and incentives in tax policies to encourage the production and trading of biological products for organic agricultural production. Apply import tax rates, VAT, special consumption tax, and environmental protection tax compatible with the level of environmental harm of agricultural production inputs. the State needs to have policies to invest in facilities and equipment for science and technology and in building a transportation system connecting production areas. The government needs to identify specific and focused environmental goals to balance state budget spending on each item.

Keywords: *Green agriculture, spending policies, government budget, tax policies*

1. Introduction

At the 26th Conference of Parties to the United Nations Framework Convention on Climate Change (COP26), Vietnam made a very strong commitment to the international community to bring net emissions to "zero" in 2050. In order to build a green economy, reduce emissions as well as implement commitments, the Government has issued many strategies such as: National strategy on climate change for the period up to 2050; National strategy on green growth for the period 2021 - 2030, vision to 2050; Strategy for sustainable agricultural and rural development for the period 2021 - 2030, vision to 2050. All of the above strategies aim to promote environmentally friendly, low-carbon, adaptive agriculture with climate change.

Developing green agriculture has been clearly oriented in the economic development policies of the Vietnamese government. Resolution No. 19-NQ/TW, dated June 16, 2022 affirms that agriculture is a national advantage and a pillar of the economy. Agricultural development needs to be associated with green, organic, circular agriculture, and market demand. The sustainable agricultural and rural development strategy for the period 2021 - 2030, with a vision to 2050 also sets the goal that by 2050, Vietnam will become one of the leading agricultural countries in the world. The agricultural product processing industry will be modern, efficient, and environmentally friendly. Green agriculture is an agriculture that effectively utilizes natural resources to improve the quality of agricultural products without affecting human health. Green agriculture aims to improve the competitiveness of agricultural products, develop technology to process and reuse by-products and waste, stabilize the economy, help farmers have a better quality of life, and protect resources and agricultural ecosystems. As a result, agriculture is sustainable on both socio-economic and environmental pillars, contributing to green economic development.

At the 26th Conference of Parties to the United Nations Framework Convention on Climate Change (COP26), Vietnam made a very strong commitment to the international community to bring net emissions to "zero". in 2050. In order to build a green economy, reduce emissions as well as implement commitments, the Government has issued many strategies such as: National strategy on climate change for the period up to 2050; National strategy on green growth for the period 2021 - 2030, vision to 2050; Strategy for sustainable agricultural and rural development for the period 2021 - 2030, vision to 2050. All of the above strategies aim to promote environmentally friendly, low-carbon, adaptive agriculture with climate change.

To gradually transition agricultural production to an agricultural economy, green agriculture, and circular agriculture, many supportive financial policies are needed, of which tax and state budget spending policies are an important content.

2. Methods

The narrative reviews are used in this paper. The research has summarized and synthesized the status of tax policy supporting green agriculture in Vietnam. The paper has also analyzed Vietnam's current status of state budget spending policies supporting green agriculture and pointed out the limitations. The purpose is to help the readers understand the reality of tax policy and the government’s spending policy. The scope of the research questions being investigated is broad: (a) What are the current status of tax policy and spending policy supporting green agriculture in Vietnam (b) What are limitations of these policies (c) how should these policies be improved? Secondary data are synthesized from domestic and foreign research

3. Results

3.1. Current status of tax policy supporting green agriculture in Vietnam

3.1.1. Overview of tax policy to support green agriculture in Vietnam

Tax laws supporting green agriculture include environmental protection tax, natural resources tax, VAT, enterprise income tax, personal income tax, import-export tax, and agricultural land use tax. Tax policies supporting green agriculture have two main roles (1) encourage clean agricultural production, application of high-tech and environmentally friendly agriculture; (2) limit the harmful risks of agriculture to the climate and environment.

(1) Tax policy encourages clean agricultural production, application of high-tech and environmentally friendly agriculture

A summary of tax policies supporting green agriculture is shown in the table below:

Table 1: A summary of tax policies policy supporting green agriculture

No	Tax law	The content of tax policies
1	**Enterprise income tax** - Law on Corporate Income Tax No. 14/2008/QH12 dated June 3, 2008. - Law No. 32/2013/QH13 issued on June 19, 2013 amending and supplementing a number of articles of the Law on Corporate Income Tax, - Law No. 71/2014/QH13 issued on November 26, 2014 amending and supplementing a number of articles of tax laws - Consolidated document No. 01/VBHN-VPQH corporate income tax law issued on January 30, 2023	- Tax exemption and tax reduction for: Income of agricultural enterprises applying high technology is exempt from tax for a maximum of no more than four (04) years and a 50% reduction in tax payable for a maximum of no more than nine (09) subsequent years. - Apply a tax rate of 10% for: Enterprise’s income from biotechnology development; environmental protection. Enterprise’s income from planting, caring for, and protecting forests; cultivating and processing agricultural and aquatic products in areas with difficult socio-economic conditions; cultivating forest products in areas with difficult socio-economic conditions; production, multiplication and crossbreeding of plant and animal breeds;

No	Tax law	The content of tax policies
		producing, exploiting and refining salt, investing in preserving post-harvest agricultural products, preserving agricultural products, aquatic products and food - Apply a tax rate of 17% for a period of ten years for: Enterprise's income from implementing new investment projects, including high-grade steel production; production of energy saving products; manufacturing machinery and equipment for agricultural, forestry, fishery and salt production; production of irrigation equipment; producing and refining animal, poultry and aquatic feed; develop traditional industries.
2	**Personal Income Tax** - Law amending and supplementing a number of articles of the Law on Personal Income Tax No. 26/2012/QH13 dated November 22, 2012. - Decree No. 65/2013/ND-CP dated June 27, 2013 of the Government detailing a number of articles of the Personal Income Tax Law. - Circular 02/VBHN_BTC dated January 4, 2024	Tax exemption for: -Income of households and individuals directly involved in agricultural production, forestry, salt making, farming, and fishing of unprocessed or only conventionally processed aquatic products that have not yet been processed into products other products. -Income of individuals who are ship owners or have the right to use ships and income of individuals working on ships that are derived from the provision of goods and services directly serving fisheries exploitation activities
3	**Value Added Tax** - Value Added Tax Law No. 13/2008/QH12 dated June 3, 2008. - Law amending and supplementing a number of articles of the Law on Value Added Tax No. 31/2013/QH13 dated June 19, 2013. - Circular No. 21/VBHN-BTC dated December 30, 2021	Non- taxable objects: -Cultivation products (including planted forest products), livestock, aquaculture, farmed and caught seafood that have not been processed into other products or have only undergone normal preliminary processing by self-producing organizations and individuals exporting, catching and selling, and at the import stage. -Specialized machinery and equipment serving agricultural production include: Subjects are not required to declare and calculate taxes: Enterprises and cooperatives that pay VAT according to the deduction method sell crop, livestock, aquaculture, and seafood products that have not been processed into other products or have only undergone normal preliminary processing to enterprises and cooperatives Apply a tax rate of 5%: mainly to agricultural products and inputs to the agricultural production process
4	**Import and Export tax** - Law on Export Tax and Import Tax promulgated by the National Assembly on April 6, 2016 - Decree No. 11/VBHN issued on June 16, 2023 of the Ministry of Finance. - Decree No. 134/2016/ND-CP issued on September 1, 2016	Tax exemption for - The goods are plant varieties; livestock breeds; Fertilizers and pesticides cannot be produced domestically and must be imported according to regulations of competent state management agencies. - Raw materials, supplies, and components that cannot be produced domestically but are imported for production of investment projects on the list of industries and trades with special investment

No	Tax law	The content of tax policies
		incentives or in areas with poor socio-economic conditions In particularly difficult situations, high-tech enterprises, science and technology enterprises, and science and technology organizations are exempt from import tax for a period of 5 years from the start of production.
5	**Agricultural land use tax** - Resolution 107/2020/QH14 dated June 10, 2020 - Circular No. 153/2011/TT-BTC guiding agricultural land use tax issued on November 11, 2011	The agricultural land use tax exemption period is extended until December 31, 2025 for all agricultural land areas serving research and experimental production; annual crop land area with at least one rice crop per year; area of land for salt production.

Source: Authors

(2) Tax policy limits the harmful risks of agriculture to the climate and environment.

Environmental Protection Tax (Environmental Protection): Law on Environmental Protection Tax No. 57/2010/QH12 and Environmental Protection Tax Schedule in Resolution 1269/2011/UBTVQH12 effective from January 1, 2012 regulate the taxation of a number of products. products whose production, import, trading, storage and consumption have certain harmful effects on the ecological environment. Among them, there are a number of products related to agricultural production such as herbicides that are restricted in use; termiticides are restricted in use; Forest product preservatives are restricted in use; Warehouse disinfectants are of a restricted use type. This contributes to changing people's awareness in using chemicals in agricultural production, promoting the development of clean agriculture and green agriculture according to world trends.

Natural Resources Tax: From January 1, 2015, according to the provisions of the Law amending and supplementing a number of Articles of Tax Laws No. 71/2014/QH13, "natural water used for agriculture, forestry, and fisheries industry, salt industry" are not subject to natural resources tax. In addition, the natural resources tax rate for wood groups V, VI, VII, VIII and other types of wood is adjusted down from 15% to 12%.

3.1.2 Assessments of tax policy to support green agriculture in Vietnam

Tax policies supporting green agriculture have had some positive effects. The productivity of using natural resources and the environment of Vietnamese agriculture is tending to be greener. Carbon ($CO2$) emissions have tended to decrease continuously since 2015, decreasing by an average of 0.1%/year. By 2023, agricultural production activities have saved 35%-50% of seeds, 35%-40% of chemical fertilizers, 30% of pesticides, and 20%-30% of labour. Meanwhile, rice productivity increased by 10%-15% and profits also increased by 10%-20%. Many safe agricultural, forestry and fishery food supply chains have been built, and the area of organic farming has increased rapidly. However, tax policies supporting green agriculture still reveal some limitations.

Firstly, the content of the regulations is not yet detailed. Criteria related to green agriculture are not clear. The level of incentives to encourage investment in production and use of environmentally friendly products, investment in environmental clean-up projects, and socialization in environmental protection fields is currently not high. Secondly, the proportion of agricultural enterprises enjoying tax incentives is still low. According to survey results on the government's tax exemption, reduction, and extension policies for agricultural, forestry, fishery, and commercial service enterprises participating in the value chain implemented in 2021 by the Department of Enterprise Development - Ministry of Planning and Investment. Only 25.6% of agricultural enterprises, 25.7% of forestry enterprises, 29.7% of seafood enterprises, and 27.5% of commercial service enterprises enjoy tax exemption, reduction, and extension policies. Thirdly, Value Added Tax Law No. 71, after a period of implementation, has revealed many inadequacies. Regulation of fertilizer as a non-taxable item to support farmers but actually increases fertilizer prices, causing losses to farmers. Fertilizer production enterprises face many difficulties.

Possible reasons include: (1) Businesses are not allowed to declare or deduct input VAT on goods and services (including investment activities and purchase of fixed assets for fertilizer production activities) but must calculate on product costs, causing prices to increase and profits to decrease, making it difficult to compete with imported fertilizers. (2) Because input VAT is not deductible, fertilizer production enterprises are not encouraged to invest, purchase, repair, and upgrade fixed assets to create new high-quality fertilizer products.

3.2. Current status of state budget spending policies supporting green agriculture in Vietnam

3.2.1. Overview of state budget spending policies supporting green agriculture in Vietnam

State budget spending policies to support green agriculture include the following documents

* Decision No. 01/2012/QD-TTg of the Prime Minister on a number of policies to support the application of Good Agricultural Production Practices in agriculture, forestry and fisheries.

According to this decision, state budget capital to develop agricultural production to ensure GAP standards is mobilized in two forms: mobilization to make initial investment and mobilization to support production development. and product consumption.

(1) The state budget invests 100% of the funding for basic investigations, topographic surveys, analysis of soil samples, water samples, and air samples to identify production areas to focus on implementing production projects. Agriculture, forestry and fisheries apply VietGAP approved by competent authorities.

(2) State budget support

a) Not more than 50% of total investment in construction and renovation of: roads, irrigation systems, pumping stations, low voltage electricity, waste treatment systems, water supply and drainage systems of concentrated production areas to comply with Vietgap technical requirements. Support funding is implemented according to Investment and Construction Management Regulations

b) Training and coaching of management staff, technical staff, and agricultural extension staff at all levels; Vocational training for rural workers to apply Vietgap in the production and preliminary processing of safe products; Compile and print documents and forms for training classes and workshops

c) One-time financial support to hire a certification organization for assessment to obtain a Product Safety Certificate.

d) Apply new technical advances in the use of pest-resistant varieties, biological pesticides, biologically derived pesticides, apply integrated pest management (IPM), and manage integrated crops (ICM);

e) Support trade promotion activities according to the provisions of Decision No. 72/2010/QD-TTg of the Prime Minister on promulgating regulations on construction, management and implementation national trade promotion program.

* Circular No. 75/2019/TT-BTC issued by the Minister of Finance on November 4, 2019, regulating the management and use of public funds from the State budget to carry out agricultural extension activities.

* Circular No. 84/2021/TT-BTC issued by the Minister of Finance on October 4, 2021, amending and supplementing Circular No. 75/2019/TT-BTC dated November 4, 2019.

Funding for agricultural extension activities is mainly taken from regular expenditures according to the provisions of the State Budget Law.

a) The Central budget ensures funding for central agricultural extension activities and technology transfer in agriculture managed and organized by the Ministry of Agriculture and Rural Development.

b) The local budget ensures funding for local agricultural extension activities and technology transfer in agriculture managed and organized by the Provincial People's Committee, District and Commune People's Committees.

3.2.2. Assessments of state budget spending policies supporting green agriculture in Vietnam

State budget spending policies are focused on prioritizing national target programs related to environmental protection. State budget expenditure policy mainly focuses on: (i) State budget expenditure for environmental causes, including central budget expenditure and local budget expenditure; (ii) State budget expenditure for national target programs related to environmental protection. According to the assessment of the World Food Policy Institute (IFPRI), Vietnam has only invested in agricultural research and development equivalent to 0.2% of agricultural GDP. Meanwhile, in Brazil it is 1.8% and in China it is 0.5%. If invested properly, Vietnam needs to reach 0.86% of agricultural GDP, which is 4 times larger than the current investment level. The state budget for environmental causes must not be less than 1% of the total state budget balance expenditure in the budget estimate. In particular, it mainly focuses on: Supporting environmental protection tasks according to the project; Implement national environmental incident prevention and response; develop and promulgate standards on environmental protection; develop strategies, planning and plans on environmental protection.

State budget spending policies for high-tech applications in agriculture are still incomplete and synchronous. There is also a lack of consistency and unity between planning and budget execution. The budget allocated to localities does not take into account comparative advantages and results in promoting sustainable agricultural transformation and clean agriculture. State budget investment capital for agriculture, especially clean agriculture, is still limited and has not been highly effective. Investment from the state budget for science and technology activities in agriculture is still small and ineffective. Research and development investment expenditure of the state budget for clean agriculture is insignificant and unstable.

4. Suggestions and Conclusion

4.1. For tax policies

Firstly, tax policy must fully and in detail cover all contents of agricultural production activities. This is a prerequisite for tax policy when implementing economic regulation goals. There must be separate regulations and incentives in tax policies to encourage the production and trading of biological products for organic agricultural production so that they can compete with chemical raw materials. The preferential mechanism can be implemented through not charging taxes or applying low tax rates on import tax and VAT. It is necessary to apply additional incentives and exemptions on corporate income tax and personal income tax for the production and business activities of these biological materials. Secondly, for organizations and individuals engaged in agricultural production that meet the standards prescribed by regulations on organic agriculture and high-tech agriculture, it is necessary to continue to exempt corporate income tax and personal income tax on this income. Agricultural products of these establishments also need to be treated favorably in terms of tax obligations (VAT, corporate income tax, personal income tax) to ensure competitiveness with other types of agricultural products. Fertilizers should be taxed with value added tax at a rate of 5%. In addition, research and development activities, human resource training, supporting production, and promotion of clean agricultural products and high-tech agriculture also need to enjoy tax incentives (incentives, exemptions, etc.). reduce corporate income tax and personal income tax). This will encourage and create favorable conditions for the formation of necessary resources for green agricultural production. Thirdly, it is necessary to develop a complete, detailed, and clear list of input materials for agricultural production and use tax policy regulations to implement this restriction. Apply import tax rates, VAT, special consumption tax, and environmental protection tax compatible with the level of environmental harm of agricultural production inputs. At the same time, incentives and exemptions on corporate income tax and personal income tax will not be applied to organizations and individuals that produce, import, and trade chemical products that cause negative impacts on humans and environment.

The government should strengthen the unity and synchronization between tax policy and other agricultural development policies. It is necessary to take advantage of social consensus in promulgating and implementing policies. This is an important content that needs attention in the process of developing and implementing tax policies to promote clean agricultural production in Vietnam.

4.2. For government spending policies

Firstly, the State needs to have policies to invest in facilities and equipment for science and technology and in building a transportation system connecting production areas. In addition, there needs to be appropriate capital allocation in programs, goals, etc. There needs to be a policy mechanism from the state budget for investment in advanced equipment and tools to serve high-tech agricultural production. Currently, the level of mechanization in agricultural production applying high technology in some stages is still low and not comprehensive. The level of equipment is still outdated. Most earthmoving machines have small capacity and are only suitable for small households and fragmented land. Secondly, the government needs to identify specific and focused environmental goals to balance state budget spending on each item. Accordingly, the focus on environmental protection is on specific issues such as protecting water and air resources, reducing carbon emissions, land resources and combating climate change. The government should spend budget more on developing transport infrastructure, public headquarters, and procurement of public transport vehicles which use environmentally friendly green technologies. The Government needs to consider increasing state budget spending for universities, research institutes, and businesses to promote research and application of advanced environmentally friendly technologies in agricultural production. Finally, it is necessary to encourage the private sector to shift production towards a green economy. Accordingly, the Government has fiscal and other incentives to promote private investment in the application of new environmentally friendly technologies. Private investment for green economic development is considered a key role alongside long-term state budget spending

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Factors Affecting the Application of Green Accounting at Manufacturing Enterprises in Hanoi

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Abstract

Nowadays, most economies recognize the importance of the environment, and environmental awareness is increasing. Green accounting practices are one of the key instruments that can help a professional firm or organization meet its social duty and commitment to sustainable development. The article will carry out the purpose of understanding and analyzing the factors that influence the survey results of green accounting information of 226 manufacturing enterprises in Hanoi. According to research findings based on data analysis with SPSS26 software, there are three categories of factors influencing the use of green accounting: (1) Factors belonging to Management Agencies, (2) Factors belonging to Professional Associations, (3) Factors belonging to Management Agencies. The paper suggests ways to enhance the application of green accounting in the sustainable development trend at manufacturing companies in Hanoi based on the findings of the research.

Keywords: *Application of green accounting, factors affecting application of green accounting, manufacturing enterprises in Hanoi*

1. Introduction

A manual on the "System of Environmental Economic Accounting" (SEEA) was originally released by the UN in 1993. The "Environmental Economic Accounting" (SEEA) application program was still being implemented by the UN in 2014. & Environmental Accounting System" (Green Accounting), and all nations are obliged to incorporate green accounting into their commercial operations. Financial professionals define "green accounting" as a modern, all-inclusive accounting system that tracks, summarizes, and reports on an organization's assets, liabilities, capital investments, revenue streams, and environmental expenses. the national green school

Green accounting helps businesses anticipate environmental impacts or some factors that can cause negative impacts on the environment, thereby helping policymakers and business administrators have ways to prevent them. and deal with those impacts. If businesses implement green accounting well, they will reduce the consumption of raw materials, fuel, and energy inputs in the production and business process. In addition, reducing the consumption of these input factors also helps businesses limit environmental pollutants, increase resource use efficiency, and increase competitive advantage by reducing production costs. Therefore, businesses increasingly need to take accountability for their environmental impacts and adopt sustainable practices as one of the most important aspects of sustainable development.

In that regard, the emergence of green accounting is unavoidable in order to satisfy the demands placed on industrial companies' activities for environmental data. Thus, using green accounting successfully promotes sustainable corporate development. This article examines the variables influencing the use of green accounting in Hanoi's manufacturing sector.

2. Literature review

Asheim (1997) believes that it is necessary to establish a green accounting or environmental accounting system to help prevent environmental pollution or limit damages caused by environmental pollution through recording costs. environment to have resources for implementing treatment measures. This accounting system also needs to consider economic measures that impact electricity production and consumption in terms of impact on the environment.

According to Van, N. T. H. (2018), green accounting is viewed as a development paradigm shift and a significant instrument for addressing the ways in which the environment affects the economy. sustainable, in the direction of building the green economy Vietnam seeks. Additionally, the author thinks that the professional association's training programs and promotional efforts help to advance the use of green accounting in Vietnam.

According to Hien, D. T. T. (2016), applying green accounting is a long-term process that requires implementation and investment research to create sustainable growth. Green accounting is a part of green growth, by people, for people, contributing to the stability of environmental and social resources for development.

According to Wu & Boateng (2010), the implementation of green accounting in firms is contingent upon the size, expertise, and level of awareness of business administrators. According to Wachira (2014), managers' worries about environmental preservation have an impact on how environmental expenses and green accounting are used in companies. According to Jalalludin et al. (2011), there are a number of internal and external factors that affect how much green accounting is used by businesses. These factors include associations, professional organizations, environmental protection organizations, and managers' and accountants' awareness and credentials.

According to Hang, D. T. T. (2019), the use of green accounting helps to provide accurate, transparent, full, and responsible information, which helps to enhance a company's reputation among management teams, investors, shareholders, and business partners. The author also thinks that the use of green accounting is impacted by corporations' understanding of social responsibility.

In short, scientists have shown that three categories of criteria influence the use of green accounting: Aspects affiliated with management firms; Aspects associated with trade groups business, Business-related Factors. This is the basis for the author to propose solutions to increase the effective application of green accounting at manufacturing enterprises in general and manufacturing enterprises in Hanoi in particular.

3. Methods

3.1. Theoretical basis

Agency theory

According to agency theory, stakeholders may be interested in an organization's environmental performance because it can affect the organization's long-term financial viability, reputation, and social responsibility position.

Agency theory further posits that ownership concentration can impact the amount of green accounting disclosure because it can reduce agency conflicts between stakeholders. When ownership is concentrated, stakeholders have more influence over the management of the business, which can lead to greater accountability and transparency. Additionally, agency theory posits that financial decisions may signal a firm's commitment to sustainability, which may increase pressure to disclose environmental information. Therefore, when a business chooses financing methods that are consistent with its sustainability goals, it sends a strong signal to stakeholders about its contributions to society and the environment.

Stakeholder theory

According to stakeholder theory, businesses must operate in a way that benefits all stakeholders, including workers, customers, suppliers, communities, and the environment. Therefore, businesses must balance the interests of all parties, including stakeholders, employees, consumers and communities. Because they are more receptive to broader stakeholder needs, organizations with more inclusive ownership structures (including more stakeholders) may be more inclined to engage in sustainability activities sustainable and publish information about their environmental impact.

Stakeholder theory is linked to the ability of a business to engage in sustainable business practices because it can also be affected by financial decisions, such as equity and debt financing.

3.2. Research model and hypothesis

From the research overview, the research team proposed the following research model:

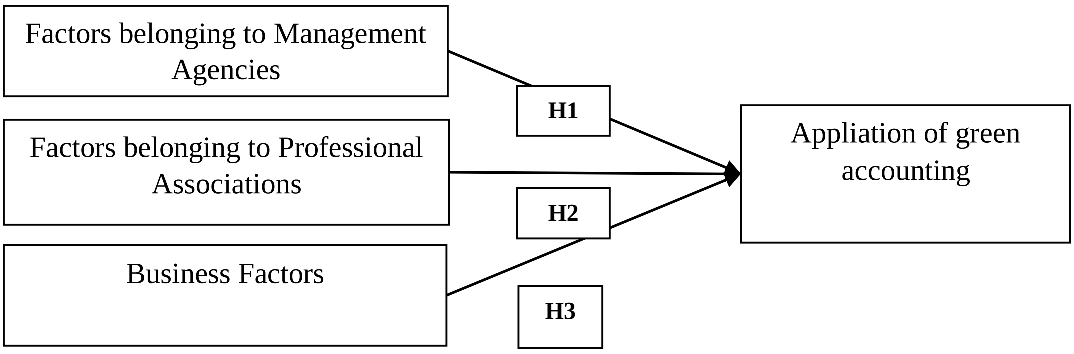

Figure 1: Research model

Source: Compiled by the author

Research model with 3 research hypotheses:

H1: Factors belonging to the management agency have a positive impact on the application of green accounting.

H2: Factors belonging to professional associations positively affect the application of green accounting.

H3: Business factors positively affect the application of green accounting.

Qualitative research methods

Qualitative method is used for the purpose of discussing the factors affecting the application of green accounting. Based on the theoretical basis that has been synthesized, the author drafted a questionnaire with two main parts: part one explores the current situation of applying green accounting, part two studies the impact of factors on the implementation of green accounting. Applying green accounting in manufacturing enterprises in Hanoi.

Quantitative research methods

Data collection: According to Hair et. al (1998), the smallest sample size should be 50, preferably 100, and the ratio of observations/measured variables should be 5/1. The research model is built with 3 groups of factors measured through 21 observed variables, so the minimum number of samples is 105, the author selected 250 manufacturing enterprises in Hanoi. The sampling method is a convenient random method.

Data processing: Survey data processing is carried out in the next stage to screen out inappropriate survey forms due to blank answers or inconsistencies in the answers. The number of survey questionnaires included for data analysis included 226 valid questionnaires. The questionnaires included in the analysis were entered and processed using SPSS software with the main analysis techniques: descriptive statistics, EFA testing and regression analysis. Finally, there is the presentation of the research results and the presentation of the article.

4. Results

4.1. Descriptive statistical results

The author conducted data processing and data analysis on 226 valid survey questionnaires obtained. The initial descriptive results are obtained in Table 1.

Table 1: Description of general information of the research sample

		Frequency	Ratio (%)
Gender	Female	128	56.64%
	Female	98	43.36
Age	Under 40 years old	86	38.05
	From 41 to 59 years old	75	33.19
	Up to 60 years old	65	28.76
Academic level	university bachelor	92	40.71
	post-university degree	134	59.29
The level of green accounting practices in enterprises	Not yet applied	98	43.36
	Have ever applied	71	31.42
	Being applied	57	25.22

Source: Results compiled from SPSS 26

Through the descriptive statistics table, it can be seen that the level of green accounting application in businesses is not high, still nearly 50% of manufacturing enterprises surveyed have not applied green accounting. Therefore, identifying factors that affect the application of green accounting at businesses is very important. On the basis of preliminary processed data, the author conducted an analysis of factors affecting the application of green accounting at manufacturing enterprises in Hanoi.

4.2. Cronbach's Alpha test

All Cronbach's alpha coefficients of the variables were ≥ 0.6, thus meeting the requirements to be included in factor analysis. At the same time, the total correlation coefficients of the observed variables all meet the requirement of ≥ 0.3, ensuring that the given scales can be trusted in a statistically significant way.

Table 2: Reliability statistics

The Scale	Observed variables	Cronbach's Alpha
Management Agencies	MA1, MA2, MA3, MA4, MA5, MA6	.868
Professional Associations	PA1, PA2, PA3, PA4, PA5	.876
Business	BN1, BN2, BN3, BN4, BN5, BN6	.902
Application of green accounting	GA1, GA2, GA3, GA4	.872

Source: Results compiled from SPSS 26

4.3. EFA exploratory factor analysis

The results of testing the data with KMO = 0.724 (> 0.5), Sig of Bartlett's Test is 0.000, less than 0.05, showing that these observations are correlated with each other and completely consistent with factor analysis. Factor loading factor of the observed variables are all > 0.5, the total variance extracted is 77.86% (> 50%) and the Eigenvalue coefficient = 1.451 (> 1). These tests were warranted for exploratory factor analysis.

Thus, all the scales selected for the variables in the model meet the requirements and can be used in subsequent analyses.

Table 3. Rotated component matrixa

KMO	0.724
Sig.	0
Eigenvalue	1.451
Cumulative %	77.86

Source: Results compiled from SPSS 26

4.4. Results of regression analysis

The results of the multivariate regression analysis of the study are as follows:

Table 4: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	Constant	.478	.214		2.235	.026		
	MA	.152	.043	.187	3.509	.001	.737	1.357
	PA	.125	.038	.180	3.245	.001	.679	1.473
	BN	.142	.051	.168	2.785	.006	.572	1.749
R= 0.738; R^2 =0.544, Adjusted R Square =0.532; F=43.566; Sig (F)= 0.000,								

Source: Results compiled from SPSS 26

The results of the regression analysis of the model of factors affecting the intention to use T with 3 independent variables are as follows: Model fit test value sig. = 0.000 (< 0.05 shows that the variables in the model can explain the change in the dependent variable.

The linear regression model shows the impact of factors affecting the application of green accounting in businesses: ***GA = 0.187*MA + 0.180* PA+ 0.168*BN + α***

Testing the regression model and research hypotheses shows that the adjusted R2 coefficient (Adjusted R Square) = 0.532 (53.2%), so the research model is consistent with the research data at 53.2%. The model does not violate the assumptions of independence of errors and the VIF coefficient <2 shows that there is no multicollinearity phenomenon.

Table 5: Results of testing research hypotheses

Content	Expected	Results	Conclude
H1: Factors belonging to the management agency have a positive impact on the application of green accounting.	+	+	Accept H1
H2: Factors belonging to professional associations positively affect the application of green accounting.	+	+	Accept H2
H3: Business factors positively affect the application of green accounting.	+	+	Accept H3

Source: Results compiled from SPSS 26

5. Conclusion

Applying green accounting is one of the useful management tools for businesses today. Therefore, it is necessary to clearly understand the factors that affect the application of green accounting to help businesses have effective solutions. Research has shown three groups of factors that have a positive impact on the level of green accounting application in listed steel manufacturing enterprises. To enhance the application of green accounting in businesses, the author proposes a number of solutions as follows.

For Businesses

First and foremost, managers' understanding of environmental protection issues and the function of green accounting must be raised. Administrators must, however, also draw attention to environmental cost aspects that are far less than the sum of money they must pay in taxes, fees, or fines resulting from ecologically detrimental behaviors school. To make wise investment decisions, business administrators require additional information regarding environmental expenses associated with commercial contracts. As a result, you can pursue project revenues while avoiding fines associated with environmental issues. The level of administrators shows the difference in awareness of green accounting. Therefore, it is necessary to improve the level of managers. On the other hand, enhance the quality of accounting human resources. Currently, because green accounting is not popular in businesses, the business's accounting department has very few accountants with knowledge of environmental accounting or specialized environmental accountants. Therefore, in the coming time, businesses need to focus on training to improve the quality of accountants, while building an accounting department with capacity and experience in green accounting.

For state management agencies

The state needs to widely propagate the benefits of environmental protection, thereby promoting environmental protection activities of businesses. Businesses that protect the environment well will have a good image among the public and consumers of that company's products and services. It is necessary to maintain and further popularize environmental-related awards for businesses such as: "green business award", green technology award, gold cup for environmental cause, Vietnam environmental award. The state needs to improve the legal system on environmental protection and sanctions. The Ministry of Finance should issue a green accounting regime for Vietnamese businesses, and issue specific guiding documents on implementing green accounting in businesses.

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Sustainable Development-oriented Environmental Accounting and Its Application in Vietnamese Accounting

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Abstract

Financial accounting typically emphasizes the accurate measurement of items, leading to the neglect of factors related to social, environmental, and sustainable development due to their challenges in reliable measurement. However, in the current context, environmental, social, and sustainable development accounting is becoming an essential area and is being adopted in many developed countries. Recording and reporting information related to sustainable development not only provides a clearer reflection of a company's financial status and business performance but also demonstrates the company's social responsibility towards sustainable development. This paper examines the limitations of traditional accounting systems regarding sustainable development and, based on the guidelines of the Global Reporting Initiative (GRI), proposes sustainable development accounting reporting indicators applicable to countries. The author argues that developing a comprehensive set of reporting indicators is a crucial foundation for establishing a complete and appropriate accounting system, particularly for Vietnam, in the process of adopting sustainable development accounting.

Keywords: *Environmental accounting, sustainable development, financial accounting*

1. Introduction

Environmental issues such as climate change, pollution, waste management, and biodiversity loss are becoming increasingly important for both governments and businesses, especially in the context of globalization and socio-economic progress. Consequently, Environmental Accounting Information Disclosure (EAID) has become an essential component of corporate reporting. According to Khuong et al. (2022), a company's environmental information provides not only financial value but also non-financial value to the environment, community, and society. EAID encompasses the reporting of a company's environmental activities, resource usage, and environmental protection measures (Zeng et al., 2012).

According to the Global Reporting Initiative (GRI), by 2022, 70% of the largest companies in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam had provided climate-related data, with 65% of Vietnamese companies adopting GRI standards (GRI, 2022). Research on Corporate Social Responsibility (CSR) reporting has gained increasing attention, showing a positive relationship between environmental information disclosure and financial performance, while voluntary disclosure enhances shareholder value (Alipour et al., 2019; Ezeagba et al., 2017).

In Vietnam, EAID has become more prevalent due to government regulations such as Circular 155/2015/TT-BTC and the amended Circular 96/2020/TT-BTC (Ministry of Finance of Vietnam, 2020). Although many companies voluntarily disclose environmental information, these regulations still require companies to demonstrate their environmental responsibility. At the same time, Vietnamese scholars have shown growing interest in researching EAID, particularly the relationship between voluntary EAID and corporate profitability (Nguyen & Tran, 2019; Nguyen & To, 2020; Nguyen & Nguyen, 2020).

This paper focuses on theoretical research, analyzing the limitations of traditional financial accounting in addressing environmental, social, and sustainable development issues. Based on international accounting standards for the environment, society, and sustainable development, the paper proposes a system of reporting indicators that should be applied to environmental accounting in Vietnam in the future.

2. Methods

In this study, the author employed a theoretical research approach to address research questions related to environmental accounting and sustainable development within the context of Vietnam. Specifically, the research focused on:

2.1. Research questions

(1) The study questions whether traditional accounting systems can meet the increasing demands for recognizing and reporting factors related to the environment, society, and sustainable development.

(2) The study also questions how to develop a system of environmental accounting reporting indicators that are aligned with the practical realities of Vietnam, based on the guidelines from the Global Reporting Initiative (GRI).

2.2. Approach to addressing research questions

Theoretical Analysis: The author conducted an analysis of existing studies to assess the limitations of traditional accounting systems in recognizing and reporting factors related to sustainable development. The author also synthesized international environmental accounting standards, particularly from the GRI, to propose a system of reporting indicators suitable for Vietnam. Development of Reporting Indicators: Based on GRI guidelines, the author proposed a system of environmental accounting reporting indicators that encompass economic, environmental, and social factors. This indicator system aims to assist businesses in Vietnam in implementing comprehensive and consistent environmental accounting reporting.

This research is primarily theoretical, providing direction for future empirical studies and laying the foundation for developing an environmental accounting system that aligns with Vietnam's sustainable development context.

3. Results

3.1. Traditional accounting and its limitations

While traditional accounting has laid a solid foundation for financial management in businesses, it exhibits several significant limitations, as pointed out by numerous researchers and experts:

- Inadequate Reflection of Non-Financial Factors: Traditional accounting systems primarily focus on financial metrics such as profit, revenue, and costs but fail to capture important non-financial factors like environmental impact, social responsibility, and aspects of sustainable development (Schaltegger & Burritt, 2000).

- Insufficient Flexibility for Modern Requirements: In the current context, where issues related to social and environmental responsibility are becoming increasingly urgent, traditional accounting often falls short in meeting the demands for recognizing and reporting relevant information (Gray, Owen, & Adams, 1996).

- Limited Long-Term Value Measurement: Traditional accounting tends to emphasize short-term results and lacks the capability to measure the long-term value of a business, especially those values related to sustainability and social responsibility (Elkington, 1997).

- Lack of Tools for Managing Non-Financial Risks: Environmental, Social, and Governance (ESG) risks are becoming increasingly important to investors and stakeholders, yet traditional accounting does not provide effective tools for assessing and managing these risks (Unerman, Bebbington, & O'Dwyer, 2007).

These limitations underscore the urgent need to improve and integrate new accounting methods, enabling businesses to manage not only their financial performance more effectively but also to ensure sustainability and social responsibility.

3.2. Recommendations for applying global reporting in the theoretical framework for environmental accounting reporting

A KPMG survey on corporate sustainability reporting reveals that in 1993, only 12% of the top 100 companies in 52 countries participated in sustainability reporting, but by 2020, this figure had increased significantly to 80%. Similarly, in 1997, 35% of the world's 250 largest companies by revenue in the Fortune 500 list engaged in sustainability reporting, and by 2020, this percentage rose to 96% (Threlfall et al., 2020). As businesses increasingly focus on sustainability reporting, U.S. environmental policy has noted reductions in water and air pollution, while greenhouse gas emissions have shown a tendency to increase. The reduction in water and air pollution is attributed to benefits outweighing costs, whereas businesses have not reduced greenhouse gas emissions due to the high costs relative to the benefits they receive (Shapiro, 2022). Chouinard et al. (2011) emphasized that integrating costs often externalized into production costs could reduce a company's competitiveness. These trends indicate that financial factors are a primary concern for businesses when deciding to engage in sustainable activities.

Although incorporating sustainability into business plans is acknowledged as essential for the long-term survival of an organization, businesses still face challenges in keeping up with sustainability-related issues, including economic, environmental, and social aspects. For instance, since the 1970s, corporate productivity has increased by 59.7%, improving living standards, but workers' productivity has only risen by 15.8%. This disparity has led to increased inequality among labor groups and between owners and workers (Fleck et al., 2011; Mishel, 2021). Sustainability reporting aims to demonstrate a company's contribution to sustainable development (Beyne et al., 2021). Throsby (2017) identified five guiding principles for sustainable development: intergenerational equity, intra-generational equity, the importance of diversity, the interconnectedness of economic, social, and environmental systems, and the prevention of irreversible impacts due to human actions.

When reporting on these principles, the outputs are often metrics, but the actual outcomes are the changes these metrics bring about in maintaining sustainable principles. According to Pucker (2021), companies often report on outputs without addressing the actual outcomes following sustainable activities, and these reports typically focus on economic, social, or environmental outcomes in isolation. Mills-Scofield (2011) argued that sustainability reporting should emphasize the actual impact that outputs have on sustainable principles. This impact shows the specific changes that have occurred due to outputs in maintaining sustainable principles (UNGC, 2015). Businesses should focus sustainability reporting on actual outcomes and impacts to provide accurate information to stakeholders about their responsibility to protect the planet and the willingness to sacrifice profits to integrate costs for the benefit of society and the environment. Companies need to measure the actual outcomes and impacts of sustainable activities and audit the information using various methods (Pucker, 2021). However, international sustainability standard-setting bodies are currently encouraging companies to produce reports that provide consistent and comparable information on their sustainable outcomes.

In the context of Vietnam's increasing integration with the world, Vietnamese businesses need to move towards standardizing Environmental Accounting Reporting (EAR) in a transparent, scientific manner, consistent with the need to provide comprehensive, multi-dimensional information to investors and partners. This trend is particularly important for listed companies, as EAR is gradually changing their reporting methods. Internationally, several organizations have issued guidelines on the content and format of financial reports related to environmental factors. Among these, the Global Reporting Initiative (GRI) sustainability reporting framework is becoming increasingly accepted. To standardize and create a unified framework for social, environmental, and sustainable development reporting, several international organizations have developed guidelines related to these factors. GRI, one of the widely recognized sources of guidance, has developed a sustainability reporting guideline system with three main categories of indicators:

1) Economic Indicators: These measure the financial and economic performance of the organization.

2) Environmental Indicators: These relate to the organization's impact on the environment, including resource use, emissions, and waste management.

3) Social Indicators: These measure the organization's impact on the community and society, including human rights, labor conditions, health and safety, and community relations.

For Vietnam, when building an accounting system, establishing and developing a system capable of providing comprehensive data for the indicators in GRI is necessary. This not only ensures that corporate accounting reports comply with international regulations but also contributes to promoting sustainable development domestically. The content of these indicators should be detailed and specifically presented according to GRI guidelines (2016).

The application of the GRI helps standardize corporate reporting, facilitating the comparison and evaluation of sustainable performance across different organizations. Moreover, it supports businesses in improving their ability to meet the needs of stakeholders, thereby enhancing their reputation and standing in the international market. The research introduces the GRI-based sustainability reporting guidelines system and proposes the application of these criteria for Vietnamese businesses.

3.2.1 Indicators reflecting economic performance

From an economic perspective, sustainable development indicators not only reflect the organization's level of development but also demonstrate its impact at local, national, and international levels. Below is Table 1, which summarizes the key indicators related to economic performance.

Table 1: Indicators of economic performance

Field	Indicator	Description	Code
Economic Performance	Economic Value Generated and Distributed	Reflects the economic value created by the organization and how it is distributed.	EP1
	Financial Implications and Risks Due to Climate Change	Assesses the impact of climate change on the organization's finances.	EP2
	Defined Benefit Plan Obligations	Includes obligations such as pensions and other financial responsibilities.	EP3
	Government Financial Assistance	Evaluates the extent to which the organization receives financial subsidies from the government.	EP4
Market Presence	Ratio of Standard Entry-Level Wage by Gender Compared to Local Minimum Wage	Compares the standard entry-level wage of employees to the local minimum wage, with consideration of gender.	MP1
	Proportion of Senior Management Hired from the Local Community	Assesses the proportion of senior management hired from the local area where the organization operates.	MP2
Indirect Economic Impacts	Infrastructure Investments	Reflects the level of the organization's investment in infrastructure services.	IEI1
	Significant Indirect Economic Impacts	Evaluates significant indirect economic impacts resulting from the organization's activities.	IEI2
Procurement Practices	Local Procurement	Measures the percentage of the organization's spending that is allocated locally.	PP1
Anti-corruption	Operations Assessed for Risks Related to Corruption	Evaluates the percentage and number of business units analyzed for corruption risks.	AC1
	Communication and Training on Anti-Corruption Policies and Procedures	Measures the percentage of employees trained on anti-corruption policies.	AC2
	Confirmed Incidents of Corruption and Actions Taken	Evaluates actions taken to combat corruption.	AC3
Anti-competitive Behavior	Legal Actions for Anti-Competitive Behavior	Assesses legal actions taken against anti-competitive and monopolistic practices, as well as the resolution of these actions.	ACB1

Source: Author’s synthesis

The table provides an overview of the key indicators that organizations should consider when assessing their economic performance.

3.2.2 Indicators reflecting environmental performance

The group of sustainable environmental development indicators assesses an organization's impact on natural ecosystems, including land, water, and ecosystems. These indicators are divided into two categories: inputs (such as materials, energy, water) and outputs (such as emissions, waste) from the organization's activities. Below is Table 2, summarizing the key indicators according to GRI guidelines.

Table 2: Indicators of environmental performance

Field	Indicator	Description	Code
Materials	Amount of materials used	Measures the amount of materials used in the organization's production activities.	M1
	% of materials from recycled products	Assesses the proportion of recycled materials used in the production process.	M2
	Products from reclamation and packaging materials	Reflects the use of products from reclamation and packaging materials.	M3
Energy	Energy consumed within the organization	Measures the energy consumption within the organization.	E1
	Energy consumed outside the organization	Assesses the energy consumed from external sources.	E2
	Strong energy	Reflects the use of strong energy sources in operations.	E3
	Reduction of energy consumption	Evaluates the measures taken to reduce the organization's energy consumption.	E4
	Reduction of energy requirements for products and services	Reflects efforts to minimize energy requirements in the production of products and services.	E5
Water	Amount of water drawn from sources	Measures the amount of water the organization uses from supply sources.	W1
	Water consumption and wastewater	Assesses the amount of water used and wastewater discharged into the environment.	W2
Biodiversity	Location and size of owned, leased, managed land	Reflects the area of land owned, leased, or managed by the organization.	B1
	Impact of activities, products, services on biodiversity	Assesses the organization's impact on biodiversity.	B2
	Protected or conserved habitats	Reflects efforts to protect or conserve natural habitats.	B3
	Strategies to control biodiversity impact	Evaluates current and future strategies to manage the impact on biodiversity.	B4
Emissions	Direct emissions to the environment	Measures the amount of direct emissions from the organization's activities.	EM1
	Total indirect emissions to the environment	Reflects the amount of indirect emissions caused by the organization's activities.	EM2
	Emission reduction initiatives	Evaluates initiatives aimed at reducing environmental emissions.	EM3
	Emissions affecting the ozone layer	Reflects the impact of emissions on the ozone layer.	EM4
	NO, CO, and other gas compounds	Measures the emissions of gas compounds such as NO, CO, etc.	EM5
Waste	Wastewater quality and discharge location	Assesses the quality of wastewater and the discharge location.	WST1
	Types of waste and treatment methods	Reflects the types of waste generated and their treatment methods.	WST2
	Tank spills	Evaluates tank spill incidents and their impacts.	WST3

Field	Indicator	Description	Code
	Transportation of hazardous waste	Measures the processes for transporting hazardous waste.	WST4
	Impact of waste on water sources	Reflects the impact of waste on the quality of water sources.	WST5
Compliance	Compliance with environmental regulations/laws	Evaluates the organization's compliance with environmental regulations and laws.	C1
Supplier Environmental Assessment	New suppliers selected based on environmental criteria	Assesses new suppliers based on environmental criteria.	SEA1
	Negative environmental impacts on the supply chain	Reflects the negative environmental impacts of the supply chain.	SE

Source: Author's synthesis

The table above summarizes key indicators for evaluating an organization's environmental performance according to GRI standards.

3.2.3 Indicators reflecting social performance

The group of indicators assessing sustainable social development focuses on measuring the impact of an organization on the social systems in which it operates. These indicators include labor practices, human rights, and critical issues affecting consumers, communities, and other social groups. Below is Table 3, summarizing the key indicators related to social performance.

Table 3: Indicators of social performance

Field	Indicator	Description	Code
Social Activities: Labor-related Indicators	Recruitment	Total workforce, contract types, new hire rate, employee benefits policies, turnover rate.	L1
	Labor-Management Relations	Percentage of employees under collective agreements, minimum notice periods for operational changes.	L2
	Occupational Health and Safety	Percentage of workforce represented in safety committees, rates of accidents, occupational diseases, absenteeism, turnover, and workplace safety training programs.	L3
	Education and Training	Annual training hours per employee, skills management programs, percentage of employees receiving regular performance and career development reviews.	L4
	Diversity and Equal Opportunity	Workforce diversity by education level, gender representation in management, equity levels within the organization.	L5
Social Activities: Human Rights-related Indicators	Non-Discrimination	Number of discrimination incidents and corrective actions taken.	HR1
	Freedom of Association and Collective Bargaining	Rights to join associations, organize, and engage in collective bargaining.	HR2
	Child Labor	Use of child labor and related risk rates.	HR3
	Forced or Compulsory Labor	Incidents of forced labor as a result of management's subjective intent.	HR4
	Security Practices	Percentage of security personnel trained on policies or procedures regarding human rights.	HR5
	Indigenous Rights	Number of incidents of violence and assault related to the local workforce and incidents addressed.	HR6
Social Activities: Community and	Local Communities	Percentage of operations with community engagement, impact assessments, development	CP1

Field	Indicator	Description	Code
Public Policy Indicators		programs; negative impacts on local communities and prevention measures.	
	Public Policy	Implementation and enforcement of public policies; amount and contributions to political parties, politicians, and other social organizations.	CP2
	Compliance	Fines and non-monetary sanctions for non-compliance with laws and regulations.	CP3
Social Activities: Product Responsibility Indicators	Customer Health and Safety	Evaluation of product health and safety impacts on consumers, and improvement directions.	PR1
	Product and Service Labeling	Information required for products and services, incidents of non-compliance, customer satisfaction.	PR2
	Marketing Communications	Compliance with laws and standards related to marketing programs.	PR3
	Customer Privacy	Number of complaints regarding customer privacy violations and data breaches.	PR4
	Socioeconomic Compliance	Incidents of non-compliance with laws and regulations related to products and services.	PR5

Source: Author's synthesis

The table above provides an overview of key indicators that organizations should consider to assess their social performance, ensuring sustainable development and responsibility toward the community and society.

4. Conclusion

In the current context, where environmental, social, and sustainable development issues are becoming increasingly urgent, the application of traditional accounting with its inherent limitations has revealed many inadequacies. Environmental accounting emerges as an inevitable solution to fill this gap, allowing for more accurate identification and reflection of critical factors that businesses need to consider.

The article highlights the limitations of traditional accounting in addressing new factors related to the environment, society, and sustainable development. Based on the guidelines from the Global Reporting Initiative (GRI), the article proposes a supplementary indicator framework alongside financial reporting, providing a more comprehensive view of business operations. These indicators not only encompass economic activities but also extend to environmental and social domains.

Although the article primarily focuses on theoretical discussions and does not delve deeply into empirical research, it serves as a starting point, opening new research directions for future scholars. The development of environmental accounting not only meets current needs but also drives Vietnamese businesses toward a more sustainable future.

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Environmental Cost Accounting in Northern Vietnam's Textile Enterprises from the Perspective of Financial Accounting

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Abstract

Environmental cost accounting is not only an effective tool to help managers run businesses better, control costs more effectively, and bring financial benefits, but it is also a competitive advantage. Huge competition for businesses, especially textile and garment businesses in the matter of globalization. This paper evaluates the current state of environmental cost accounting in textile enterprises in Northern Vietnam from the perspective of financial accounting and proposes solutions to improve environmental cost accounting in these enterprises.

Keywords: *Environmental cost accounting, financial accounting, Northern textiles*

1. Introduction

The global trend of sustainable development requires businesses to set development goals, based on a close connection between production and business activities and environmental protection. To achieve this, in addition to basic information about revenue, costs, and profits as before, administrators need to pay attention to information about environmental costs arising at the enterprise. More than ever, administrators understand that the money spent on controlling and reducing environmental pollution is not purely a cost but an investment in the future, to increase value and image, brand for businesses.

Identifying, measuring and accounting for environmental costs that affect the presentation and provision of information on financial statements helps businesses effectively manage their environmental activities, avoid high costs and deal with them. Administrative fine from management agency. The textile industry is one of the sectors that significantly pollutes and degrades the environment. Wastewater generated from various stages of the textile and dyeing process contains large amounts of pollutants that are highly harmful to both health and the environment if not properly treated. This is the reason why many domestic and international textile enterprises need to make appropriate changes in response to actual conditions and increasingly focus on environmental cost accounting.

Although the benefits and importance of environmental cost accounting have been researched in many different documents, in developing countries there are still many limitations, so researching environmental cost accounting Market research in Northern Vietnam Textile and Garment enterprises from a financial accounting perspective is extremely necessary and of utmost importance.

2. Literature review

Currently, many guidelines on environmental cost accounting have been published by various accounting organizations and associations worldwide, such as the United Nations Sustainable Development Commission (UNDSD), the United States Environmental Protection Agency (USEPA), the International Federation of Accountants (IFAC), the Institute of Chartered Accountants in England and Wales (ICAEW), the Canadian Institute of Chartered Accountants (CICA), and the New Zealand Institute of Chartered Accountants (ICANZ).

Most of these guidelines have reached a high level of consensus in defining the content of environmental cost accounting within enterprises. Environmental cost accounting is generally designed to assist in environmental management and the management of environmental entities within an enterprise. The role of environmental cost accounting is becoming increasingly important for manufacturing enterprises, but it is not given the same level of attention across different enterprises. This lack of attention stems from the perception among managers that environmental costs at their units are insignificant, particularly from the perspective of financial accounting.

It can be argued that if environmental costs are considered immaterial, decisions regarding the management of environmental costs are unlikely to be made. If a manager does not recognize the benefits of environmental accounting, the likelihood of environmental cost accounting being applied for the purpose of environmental cost management is low.

In Vietnam, research, implementation, and application of environmental cost accounting in enterprises are still novel and face many challenges. Environmental costs are often associated with an enterprise's environmental activities, but from an accounting perspective, these are costs that affect the financial position of the enterprise.

Environmental costs related to business activities are increasing due to the rise in environmental regulations and social demand for sustainable development. A significant number of studies, including articles published in specialized scientific journals, doctoral dissertations, and textbooks, have demonstrated the environmental pollution damages caused by enterprises, which in turn drive the implementation of environmental cost accounting.

Domestic research on environmental cost accounting in manufacturing enterprises from the perspective of financial accounting

According to statistics, research works related to environmental cost accounting from the perspective of financial accounting are still very limited. These studies primarily focus on defining environmental accounting and orienting the development of environmental cost accounting within Vietnam's accounting system.

The article “Experimental Study on Environmental Management Accounting at Machino Vietnam” by Nguyen Thi Anh Tuyet and Pham Chi Quang, published in the Proceedings of the 20th Scientific Conference, Hanoi University of Science and Technology (2006), recalculated the cost structure of certain products at Machino Dong Anh Company. The results showed that environmental costs accounted for a significant proportion of total costs, primarily including energy costs and solid waste treatment costs. The study also demonstrated the feasibility of applying environmental cost accounting in Vietnamese manufacturing enterprises.

Bui (2010) in her dissertation "Research on Environmental Cost Management and Accounting Models in Vietnam’s Coal Mining Enterprises" elucidated the theory of environmental cost accounting, developing a model for environmental cost management in coal mining enterprises based on three groups of activities (direct environmental protection activities; reasonable exploitation and use of minerals; and other activities).

The author clarified environmental costs that were previously hidden in general accounts, recalculating product costs to account for environmental factors. However, the study's limitations include not identifying research gaps, lacking a clear research methodology, and not providing a comprehensive theoretical basis. The study primarily classified environmental costs by activity without addressing environmental reporting and the indicators used to analyze environmental efficiency. It did not adequately address the roles of both physical and monetary environmental information in cost management. Furthermore, the study's findings and solutions focused more on environmental management than on environmental management accounting.

The article “Environmental Accounting and Its Application in Vietnam” by author Duong (2008) addressed the identification of environmental cost elements in Vietnam and oriented environmental costs as a field of accounting that supports environmental management for managers and specialists. However, to date, financial regulations, accounting standards, and regimes have not provided the necessary information on environmental-related costs required for decision-making and financial reporting. In practice, environmental costs are not accounted for in a separate, distinct account, with many environmental-related costs being reflected in general cost accounts. As a result, economic managers cannot identify or discern the scale and nature of overall environmental costs and specific environmental cost items.

Most accounting accounts do not record significant environmental costs, such as repair costs, compensation, remediation costs, and costs associated with cleaning up or destroying ecological and living environments.

The document "Environmental Accounting in Enterprises" by authors Pham and Tran (2012) focused on clarifying the basic theoretical issues regarding environmental accounting in enterprises, such as the concept of environmental cost accounting, environmental benefit accounting, and the evaluation of environmental performance.

The authors proposed methods for classifying and identifying environmental costs in enterprises, recording, and providing environmental cost and revenue information. However, in discussing the elements of environmental cost accounting, the authors did not extensively address financial environmental cost accounting within the enterprise accounting system.

International research on environmental cost accounting in manufacturing enterprises from the perspective of financial accounting

In traditional accounting systems, environmental costs are often "hidden" within general production costs (UNDSD, 2001; Rikhardsson et al., 2005; Schaltegger, S. & Wagner, M. (2005). Consequently, this system presents a vague view of the scale and scope of environmental cost generation and the environmental impact from the business operations of an enterprise, leading to incomplete and inaccurate information (IFAC, 2005). This impact has driven the development and refinement of traditional accounting systems associated with the environment.

According to Venturelli, A. & Pilisi, A. (2005).), environmental costs in industrial enterprises in Italy consist of three main groups: prevention costs, monitoring costs, and failure costs (costs for errors). Prevention costs involve implementing measures to prevent and avoid negative impacts on the environment. Monitoring costs involve managing and overseeing the environmental management system and its effectiveness. Failure costs include internal and external failure costs.

Environmental costs are not fully presented in financial reports (UNDSD, 2001). Reports on environmental costs (if any) are often limited by a small amount of information such as: costs of environmental pollution control equipment and fines. Therefore, financial accounting is used to prepare financial reports to serve the information needs of stakeholders outside the business (investors, creditors, taxes, etc.), objectives Financial accounting is to provide accurate information about the financial activities of enterprises, regulated by international accounting standards and accounting standards of each country.

3. Theoretical framwork for environmental cost accounting in manufacturing enterprises

3.1. Concept of environmental cost accounting

In various countries around the world, environmental cost accounting has garnered significant attention from both researchers and accounting practitioners. Environmental cost accounting has been studied and implemented in developed countries in Europe, America, and some Asian countries like Japan and South Korea, and has since expanded to developing countries, including Vietnam.

However, the application of environmental cost accounting in enterprises still faces many limitations and challenges. Alongside the development and expansion of environmental accounting, numerous studies have been conducted by international organizations, yet there is almost no independent research on environmental cost accounting.

Currently, there are many definitions of environmental costs from different perspectives, but there is no consensus on a unified concept of environmental costs (IFAC 2005).

According to the traditional view, environmental costs are the expenses for environmental protection through recycling and waste treatment. However, this perspective is neither entirely correct nor sufficient, as it overlooks the costs associated with efforts to minimize resource use and the material costs of waste. This omission hinders the ultimate goal of environmental accounting, which is to provide information to help managers make appropriate decisions. Environmental costs are also considered to include site cleanup costs after production and wastewater treatment costs. Environmental management policies that focus on environmental treatment costs and end-of-pipe technology may generate short-term profits, but in the long term, they will be costly as they increase waste costs due to inefficient resource use.

According to UNDSD (2001, p. 11), environmental costs are understood as all expenses associated with environmental damage and protection by the enterprise, including costs for preventing environmental damage, waste disposal costs, environmental protection planning costs, environmental control costs, and costs for remedying damages that may affect the enterprise and the community.

According to Jasch, C (2003), environmental costs may include waste treatment costs, prevention costs, remediation costs, investment costs related to environmental issues, or external costs such as taxes, fees for waste generation, and fines for violating environmental protection regulations. Most of these costs are not systematically recorded and are not allocated or attributed to the responsible products or processes, but are simply recorded in the total production costs. The incomplete recording of environmental costs leads to distorted and inaccurate calculations. Therefore, the author suggests that it is necessary to clarify the concept of waste, as it represents materials that have been purchased and paid for but have not been transformed into products, indicating inefficiencies in production. Thus, the material costs, labor costs, and capital wasted in creating outputs that are not products should be recognized as environmental costs.

According to Lee, B.W., Jung, S., and Kim, J. (2004), environmental costs are the direct and indirect costs related to preventing or mitigating environmental impacts during the product production process. From a macroeconomic perspective, environmental costs include both internal environmental costs within the enterprise and external costs (social costs) under the government’s responsibility, such as losses in labor resources due to pollution, damages from the destruction of ecosystems, and the depletion of natural resources.

Within the scope of this study, the author focuses solely on the internal environmental costs of enterprises, while external environmental costs, which affect society but are not the direct responsibility of enterprises and are not included in product production costs, are excluded.

To determine environmental costs within enterprises, it is essential not only to consider the costs of environmental protection but also to pay attention to the costs associated with waste formation (in solid, liquid, or gaseous forms). Waste is formed from materials purchased and paid for by the enterprise but not transformed into commercial products. Environmental costs can be offset by revenues from selling by-products, waste products, rewards for pollution control, or through licensing clean technology. Identifying and understanding where environmental costs originate and how much they amount to will help enterprises accurately calculate costs and set product prices.

Although there are many different concepts of environmental costs, scientists generally agree that environmental costs are the expenses incurred from environmental protection activities, due to the impacts of the enterprise’s production and business activities on the environment.

Based on a synthesis and analysis of the concepts of environmental costs presented by organizations and individuals, the author argues that "Environmental costs are recognized as environmental protection costs and waste costs. Environmental protection costs are associated with the enterprise’s environmental protection activities as stipulated in the Environmental Protection Law, including costs for preventing and mitigating adverse environmental impacts, responding to environmental incidents, pollution remediation, degradation improvement, environmental restoration, and the rational exploitation and use of natural resources to maintain a clean environment. Waste costs include the material costs and processing costs of waste."

3.2. Characteristics of environmental costs

From the perspective of identifying environmental costs as the expenses associated with environmental protection and waste management, these costs can be recognized when they meet the following characteristics:

Environmental costs are those expenses incurred during the business operations of an enterprise. These costs arise internally within the company and include hidden costs, contingency costs, and expenses related to the flow of materials and energy.

Costs associated with environmental issues within the enterprise encompass preventive measures, mitigation, and environmental control; the treatment and remediation of the environment; the rectification of environmental incidents; the improvement of technology and production processes towards environmental sustainability; and the damages or losses related to natural resources, financial implications, corporate image, and reputation that the enterprise may suffer due to environmental harm.

Environmental costs are linked to the remediation and prevention of current and future environmental damage that may occur as a result of the enterprise's business activities impacting the environment. Consequently, these costs are highly contingent.

Environmental costs include both mandatory and voluntary expenses. These costs may increase or decrease depending on the enterprise's efforts to protect the environment.

4. Results

4.1. The current state of environmental cost accounting in northern Vietnamese textile enterprises from the perspective of financial accounting

4.1.1. The current state of environmental cost accounting information collection

Based on a survey of the accounting documentation systems used by 45 textile enterprises in Northern Vietnam, it was found that 80% of these enterprises adhere to the accounting regime under Circular 200/2014/TT-BTC, issued on December 22, 2014, by the Ministry of Finance. The remaining 20% of enterprises utilize Circular 133/2016/TT-BTC (effective from January 1, 2017).

For documentation reflecting environmental costs incurred within the enterprise, such as wages and salaries for sanitation workers; depreciation of waste treatment equipment and dust reduction systems; taxes, fees, and charges; or outsourced services, the enterprises use various types of documentation, including invoices, warehouse release slips, payment slips, timesheets, payroll sheets, and fixed asset depreciation calculation sheets. The enterprises organize the collection of economic transactions' information according to the prescribed templates, ensuring clarity, completeness, and timeliness, thereby meeting the requirements for information collection to support bookkeeping and financial reporting.

To gather information on environmental treatment costs for the aggregation of environmental costs, to serve cost control, and to allocate environmental costs, most surveyed textile enterprises use the documentation guided for financial accounting, without designing new templates or adding additional indicators on the accounting documentation. For example, at Ha Phong Export Garment Company - Bac Giang, when environmental costs arise, the company will use the following documents:

- *For the depreciation costs of waste treatment equipment*: Depreciation costs for fixed assets belonging to specific workshops are calculated using a fixed asset depreciation sheet. These costs are then allocated according to production volume. The company's accounting department will compile a depreciation sheet for these treatment devices.
- *For wage costs:* The sanitation workers responsible for cleaning the areas between production workshops and daily collection of solid waste are employed on a contract basis, with a fixed wage agreed upon by the company.

***Environmental management department*:** At the company, the environmental management department, overseen by the KCS - ISO division, is responsible for overall environmental management. This department provides recommendations and proposals for waste reduction, dust control, and annual environmental impact assessments. They also develop and inspect fire prevention and control measures. The accounting department prepares timesheets and payroll for this department.

- *For taxes, fees, and charges:* Based on monthly VAT invoices for environmental-related fees, charges, and taxes incurred at the company, including wastewater discharge fees based on water usage, industrial waste fees, waste transportation fees, and solid waste treatment fees based on waste volume, the accounting department will issue payment slips.

- *For other outsourced services:* These include office supplies, telephone charges, postage, conferences, and hospitality expenses incurred by the environmental management department (KCS - ISO). The accounting department will issue payment slips.

4.1.2. The current state of environmental cost accounting information processing

A survey of textile enterprises in Northern Vietnam revealed that 80% of textile enterprises chose to apply the accounting system according to Circular No. 200/2014/TT-BTC, issued on December 22, 2014, by the Ministry of Finance. The remaining 20% of textile enterprises apply the accounting system according to Circular 133/2016/TT-BTC (effective from January 1, 2017). Regarding information related to environmental costs, the enterprises simultaneously monitor these costs using the accounts established within the company.

Expenses related to environmental protection activities, depending on their intended use, are reflected by the accounting department in accounts for general production costs, enterprise management costs, or other expenses.

From the results of investigations, interviews, and research into the accounting practices at textile enterprises in Northern Vietnam, it was found that environmental costs incurred by these enterprises are primarily aggregated into two main accounts: Account 627 – General Production Costs and Account 642 – Enterprise Management Costs, despite many environmental costs being obscured within these aggregated accounts.

At the accounting department of LGG Bac Giang Garment Company, environmental costs incurred will be accounted for as follows:

- *For depreciation costs of waste treatment equipment:* The company's office accounting department will compile a depreciation sheet for the treatment devices, which is then allocated to Account 6274.
- *For outsourced service costs:* These expenses are recorded under Account 6277.
- *Environmental management department:* At the company, the environmental management department, overseen by the KCS - ISO division, has its costs accounted for under Account 6421 - Management Personnel Costs.
- *For taxes, fees, and charges:* Environmental-related taxes, fees, and charges incurred by the company are accounted for under Account 6425 - Tax, Fee, and Charge Costs.
- *For other outsourced service costs:* These are accounted for under Account 6427 - Outsourced Service Costs.

Additionally, based on the survey of actual practices, 40 out of 45 enterprises use accounting software through computerized accounting methods, indicating that these enterprises maintain detailed and comprehensive accounting records suitable for their business operations. The accounting department records accounting entries according to the sequence and method prescribed for economic and financial transactions related to environmental activities within the enterprise. Of the surveyed enterprises, 80% use general and detailed accounting records as guided by Circular No. 200/2014/TT-BTC, issued on December 22, 2014, by the Ministry of Finance, while 20% use accounting records according to Circular 133/2016/TT-BTC (effective from January 1, 2017). However, all enterprises surveyed have not designed specific accounting record templates to document the economic transactions related to environmental cost categories.

4.2. The current state of providing and utilizing environmental cost accounting information

4.2.1 The current state of providing and utilizing internal environmental cost accounting information

In textile enterprises in Northern Vietnam, the primary users of internal environmental cost accounting information are managers and operational executives. These individuals are legally responsible and must adhere to environmental protection regulations while effectively utilizing resources for environmental conservation. Consequently, it is crucial for managers to have a thorough understanding of the environmental cost information within their enterprises.

Based on the survey results regarding the demand for environmental cost accounting information among textile enterprises in Northern Vietnam, the following findings have been obtained:

Table 1: Demand for environmental cost information within enterprises

Information Need	Number of Enterprises	Percentage (%)
1. Total Environmental Costs in the Enterprise	45/45	100
2. Environmental Costs per Department	40/45	85.71
3. Environmental Costs per Product	43/45	94.28
4. Information on Materials in Waste	25/45	55.55

Source: Compiled from the author's survey results

Thus, almost all surveyed textile enterprises in Northern Vietnam believe that their accounting systems should provide environmental cost information including total environmental costs per department, per product, and information on materials in waste. The surveyed environmental cost accounting information will help these enterprises make decisions related to controlling environmental operational costs and allocating environmental costs to different products.

Currently, surveyed textile enterprises have not prepared environmental cost reports, but their environmental departments have prepared environmental impact assessment reports.

Table 2: Emission loads from boilers in textile enterprises in Northern Vietnam

No.	Indicator	Concentration of Harmful Substances (mg/m³)	Emission Load (g/h)	Emission Load (tons/day)	Emission Load (tons/year)
		Production Line 1			
1	Total Dust	96.8	32,154.00	0.84	303.94
2	SO_2	148.8	62,312.00	1.54	563.39
3	NO_2	66.1	22,985.50	0.67	225.15
4	CO	267.7	114,518.50	2.79	1,020.70
		Production Line 2			
1	Total Dust	74.65	34,907.88	0.83	305.79
2	SO_2	133.5	60,169.20	1.44	527.08
3	NO_2	45.2	22,483.04	0.56	205.71
4	CO	211.7	112,884.24	2.70	988.86

Source: Ha Phong Export Garment Joint Stock Company

4.2.2. Status of provision and use of environmental cost accounting information external to the enterprise

External users of environmental cost information in textile enterprises in Northern Vietnam include investors, banks, suppliers, and service providers. These stakeholders have varied and significant economic interests and are concerned with the impact of environmental activities on the financial condition of the enterprise.

To assess the demand for environmental cost accounting information among these external stakeholders, the author conducted surveys with senior credit officers from various banks, as well as staff involved in environmental matters at Environmental Protection Departments, Statistical Offices, and Planning and Investment Departments in Bac Giang Province, Bac Ninh Province, Hung Yen Province, Nam Dinh Province, and Hanoi City.

The results of the survey on the need for environmental cost accounting information for external stakeholders are summarized as follows:

Table 3: Environmental information required for external stakeholders

Content	Disagree %	No Opinion %	Agree %
1. Environmental policies of the enterprise	20	30	50
2. Efforts of the enterprise in environmental protection	15	25	60
3. Environmental violations and penalties incurred by the enterprise	20	30	50
4. Benefits received by the enterprise from environmental protection	15	40	45

Source: Compiled from the author's survey results

It can be observed that the surveyed stakeholders believe that external users of information need access to all the environmental information mentioned above. Additionally, they suggest the inclusion of other necessary environmental cost information, as detailed in the following table:

Table 4: Environmental cost information required

Content	Disagree %	No Opinion %	Agree %
1. Waste treatment costs (depreciation of waste treatment equipment, taxes, fees, fines for non-compliance with environmental laws, etc.)	0	10	90
2. Costs for environmental prevention and management	20	25	55
3. Costs for environmental research and development	25	35	40
4. Costs for legal environmental compliance	0	10	90

Source: Compiled from the author's survey results

The survey results indicate that 90% of respondents believe that costs for legal environmental compliance should be clearly presented in the enterprise's financial reports. This information is used to assess the level of environmental compliance, evaluate risks, and determine the enterprise's operational continuity. Most respondents believe that current practices do not meet the needs of external information users, as very few textile enterprises in Northern Vietnam disclose environmental information in their financial reports.

The reasons for this include a lack of accounting standards and detailed guidelines for environmental information disclosure, and insufficient specific guidance on environmental accounting methods in the accounting regulations or circulars. Additionally, disclosing environmental information may harm the enterprise's reputation and involve significant costs for information collection.

4.2.3. Causes of inadequacies in environmental information disclosure in financial reports of textile enterprises in Northern Vietnam

The survey results in Table 5 indicate that there is a consensus on the need for mandatory regulations requiring textile enterprises to disclose environmental information in their financial reports. Such regulations would serve as a motivation for enterprises to engage more seriously in environmental protection.

In the Northern textile enterprises surveyed: 36 out of 45 enterprises (80%) prepare financial reports according to Circular No. 200/2014/TT-BTC dated December 22, 2014, issued by the Ministry of Finance. 9 out of 45 enterprises (20%) prepare financial reports according to Circular No. 133/2016/TT-BTC.

Table 5: Causes of inadequacies in environmental information disclosure

Content	Disagree %	No Opinion %	Agree %
1. Lack of accounting standards and detailed guidelines for environmental information disclosure	5	15	85
2. Lack of specific guidelines for environmental accounting methods in accounting regulations or circulars	10	5	85

Content	Disagree %	No Opinion %	Agree %
3. Disclosure of environmental information may harm the enterprise's reputation	10	10	80
4. Providing environmental information incurs high costs for data collection	10	20	70

Source: Compiled from the author's survey results

According to the current financial reporting templates, environmental-related indicators are not presented and disclosed independently. Consequently, environmental cost indicators are primarily recorded in the income statement, under general categories such as cost of goods sold, management expenses, and other expenses. In the financial statement notes, environmental costs are typically included under "Production and business expenses by factors."

5. Recommendations

Improving environmental cost information collection

Accounting documents

Based on the guidance provided by Circular No. 200/2014/TT-BTC dated December 22, 2014, and Circular No. 133/2016/TT-BTC, enterprises should select appropriate accounting documents to capture information on environmental activities. When costs related to materials, labor, etc., arise from environmental activities (e.g., wastewater treatment, waste oil management, incineration), the accounting staff should clearly state in the summary of the economic transaction that it is an environmental cost. Additionally, environmental symbols (MT) can be added to the documents to facilitate recording in the relevant accounting accounts.

To collect environmental cost information for financial accounting purposes, input documents, including primary materials, auxiliary materials, fuel, and energy, should be assigned suitable codes for each type. This helps in identifying costs by cost centers and should include additional symbols for material sources and suppliers, aiding in the accurate recording of environmental cost accounting.

For waste generated from production and business activities, enterprises need to classify the waste, determine the material costs associated with the waste for each cost center, and provide information for recording in the environmental cost accounting ledger to prepare the material flow balance report.

Accounting accounts

In the author's opinion, textile enterprises in Northern Vietnam should retain the current accounting system in use. However, certain production cost accounts need to be detailed to include environmental costs. The method for encoding detailed accounts depends on each enterprise based on the existing accounting system and the accounting software used.

Currently, textile enterprises in Northern Vietnam utilize specialized accounting software. Encoding environmental cost accounts would facilitate the rapid extraction of data related to environmental costs as required by management, thereby supporting cost control and decision-making processes. Correspondingly, accounting departments in textile enterprises should maintain detailed cost ledgers to provide information to management.

Accounting ledgers

To record waste material costs, enterprises may use a detailed material ledger template with the following content: Date and month of ledger entry; Document number, date, and month of the document used for the entry; Description of the economic transaction; Unit price; Quantity and value of input materials; Costs of output materials in positive and negative products, with material costs in positive and negative products detailed by quantity and value.

Enhancing environmental cost accounting information processing

Based on the entire production and business process of the enterprise, it is necessary to identify the centers generating waste within the production process. These centers should be directly associated with the waste generated in those departments. The enterprise needs to maintain detailed ledgers for material costs. Additionally, to record waste material costs, the enterprise can use a detailed material ledger template with the following content: Date and month of ledger entry; Document number, date, and month of the document used for the entry; Description of the economic transaction; Unit price; Quantity and value of input materials; Costs of output materials in positive and negative products, with material costs in positive and negative products detailed by quantity and value.

Enhancing the provision of environmental cost accounting information

To provide information to external stakeholders, evaluate the level of environmental investment, assess environmental risks, and measure the effectiveness of environmental cost management, the company's accounting reports need to be completed and supplemented with environmental financial information in the notes to the financial statements. Environmental costs should be classified and presented in the following categories:

- Waste treatment costs,
- Costs for environmental prevention and management,
- Costs of non-product outputs.

In addition to providing information to external stakeholders through financial statements, the company should also prepare environmental management accounting reports to provide information to internal managers for decision-making related to both financial and environmental matters. Environmental cost reports should be prepared and presented according to the specific management requirements of the company. Among the information related to environmental activities, environmental cost information is of utmost importance as it primarily helps companies control and manage environmental costs. This group of reports primarily includes analyses of profitability in certain cases such as: investment projects (e.g., constructing a new plant, modernizing technology, waste management systems, etc.); new product development projects; packaging design and production; and product distribution systems.

To serve decision making, when preparing an environmental cost report, the need for environmental cost information includes the following necessary contents:

- Environmental cost information for the entire company, each department, each product, and each environmental cost center. This information helps managers identify and etermine the sources of costs and the entities bearing these costs, thereby enabling proper allocation of environmental costs to each activity and cost-bearing entity (products).
- Environmental cost information is provided to administrators through the means of environmental cost reports. The recipients of information are the enterprise's Board of Directors and those involved in managing and operating the enterprise's production and business activities.

Environmental cost reports can be prepared flexibly by month, quarter, and year. Enterprises can use the following types of reports: (1) Environmental cost report by department, (2) Environmental cost report by material flow, (3) Environmental cost summary report.

6. Conclusion

In Vietnam, Environmental Cost Accounting is a new field, playing an important role for every business and those with direct and indirect benefits.

Environmental cost accounting from a financial accounting perspective is only best promoted when environmental cost accounting information is provided fully, promptly, transparently, and ensures trust for users. The completeness, timeliness, and reliability of environmental cost accounting information largely depend on the quality and effectiveness of the environmental cost accounting organization. As an important part contributing to the economic development of each country, manufacturing enterprises in general and Northern Vietnam Textile enterprises in particular, are always responsible for valuing and accounting environmental costs. adequate environment, increasing business efficiency while implementing active environmental protection measures, ensuring the sustainable development of the business.

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SECTION IV

ECONOMIC - SOCIAL SUSTAINABILITY

Sustainable Marketing Mix's Influence on Green Brand Image: The case of Vietnam's Fashion Industry

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Abstract

This study investigates the impact of sustainable marketing strategies on the green brand image within Vietnam's fast fashion industry. Recognizing the significant environmental issues posed by fast fashion, this research addresses the role of sustainable marketing in enhancing consumer perceptions and fostering brand loyalty. By employing the SOR (Stimulus-Organism-Response) psychological model, the study examines how sustainable product features, eco-friendly pricing, green distribution practices, and environmentally conscious promotions serve as stimuli that influence consumer behavior and attitudes. A survey of 692 Vietnamese consumers aged 18 to 30 was conducted, utilizing a 5-point Likert scale to measure responses. The results indicate a strong positive correlation between sustainable promotional strategies and green brand image, followed by significant impacts from sustainable product and place strategies, with sustainable pricing strategies also contributing positively but minimally. These findings suggest that fast fashion brands should prioritize sustainable marketing across all elements of the marketing mix to build a robust green brand image. The study provides strategic insights for brands seeking to align with consumer values on environmental sustainability and highlights the importance of transparent communication and eco-friendly practices.

Keywords: *4Ps, consumer behavior, fast fashion, green brand image, sustainable marketing*

1. Introduction

Sustainable marketing is increasingly becoming a pivotal topic in discussions surrounding environmental issues, particularly in the context of the fast fashion industry. According to MacArthur (2013), the fashion industry generates millions of tons of waste annually, largely driven by the production and consumption of fast fashion products. This places a substantial burden on waste management systems and the environment. Water resources, vital for human survival, are also severely affected by fast fashion practices (WWF, n.d.). Additionally, the chemicals used in fast fashion production pose serious threats to both the environment and human health (Bathmathan *et al.*, 2019). These reports clearly illustrate that the fast fashion model not only has a negative environmental impact but also faces significant challenges that need to be addressed in the future.

In response to these issues, fast fashion brands have quickly implemented "sustainable" marketing strategies to build and enhance customer trust. Major brands such as Zara and H&M continuously employ these strategies to remain relevant in the societal trend towards environmental protection (Dzhengiz *et al.*, 2023). While there is ongoing debate about the true sustainability of these marketing strategies, their significant impact on the fashion industry cannot be denied.

Despite several prior studies focusing on different factors influencing customers' purchase decisions in the fast fashion industry (Hu & Shiau, 2015; Stringer *et al.*, 2019; Thuong, 2019), most have overlooked the role of sustainable marketing strategies in shaping the green brand image. Therefore, this study aims to elucidate how sustainable marketing strategies enhance the green brand image of fast fashion brands in Vietnam.

To conduct this research, the authors conducted a survey targeting the age group of 18 to 30, who typically show a particular interest in fashion products and possess knowledge about fashion trends in general and fast fashion in particular (Joy *et al.*, 2012). This age group also usually has disposable income, allowing them to spend on their preferred fashion brands. Moreover, they have a significant influence on environmental issues (Mahamoud *et al.*, 2018). They are aware and mature enough to express their views on the current environmental situation and have the knowledge to demand specific actions from governments, organizations, and businesses to protect the environment (Awan, 2011). For fast fashion brands, this is the target customer group, making it crucial to understand their desires and perspectives to devise appropriate business strategies (Dzhengiz *et al.*, 2023).

2. Literature review and Hypothesis development

2.1. Theoretical framework

Green brand image refers to consumers' perceptions and associations regarding the environmental sustainability and eco-friendliness of a brand. In the fast fashion industry of Vietnam, building a strong green brand image is essential for differentiating brands in a highly competitive market. According to Chen et al. (2017), a green brand image positively influences consumers' environmental attitudes and behaviors, leading to greater brand loyalty and advocacy.

Sustainable marketing is a key strategy for enhancing green brand image. It involves integrating environmental considerations into the marketing mix—product, price, place, and promotion. Peattie & Charter (2003) emphasize that sustainable marketing strategies not only meet customer needs but also consider the long-term impact on the environment. By adopting sustainable practices, fast fashion brands can create a positive green brand image, which in turn influences consumer behaviour.

The Theory of Planned Behaviour by Ajzen (1991) suggests that behaviour is influenced by attitudes, social norms, and perceived control over the behaviour. In the context of green consumerism, Carrington, Neville, and Whitwell (2010) found that consumers' willingness to purchase sustainable products is significantly influenced by their attitudes towards sustainability and social norms.

In the fast fashion industry, the SOR psychological model (Stimulus-Organism-Response) by Mehrabian & Russell (1974) provides a useful framework for understanding how sustainable marketing stimuli affect consumer behaviour. Stimuli, such as eco-friendly product attributes and green promotional messages, can evoke positive emotional responses in consumers (Organism), leading to increased purchasing decisions and brand loyalty (Response). By effectively utilizing the SOR model, brands can design marketing strategies that enhance their green brand image and drive sustainable consumer behaviors.

Building on this theoretical foundation, the present study aims to investigate the impact of a sustainable marketing mix on the green brand image in Vietnam's fast fashion industry. This includes examining how product sustainability, eco-friendly pricing strategies, green distribution practices, and environmentally conscious promotions contribute to a positive green brand image.

2.2. Literature review

2.2.1. Theoretical foundation of the research

The proposed model and its associated hypotheses are rooted in the conceptual framework of the SOR model, originally introduced by Mehrabian & Russell (1974) within the realm of environmental psychology. This framework has since been expanded to various contexts, including the retail sector and other domains of consumer behaviour research. According to the SOR paradigm, environmental stimuli exert influence on an individual's cognitive and affective reactions (Organism), subsequently shaping behavioural responses.

Stimuli, as conceptualized by Bagozzi (1986) in the context of consumer behaviour, encompass marketing mix variables and other environmental inputs that elicit emotional responses. The Organism component of the SOR framework represents the internal state of the individual mediating between stimuli and behavioural responses. Initially characterized by Mehrabian and Russell as pleasure, arousal, and dominance (PAD), the Organism construct has been reconceptualised by subsequent scholars as cognitive and affective internal states.

These psychological constructs, the affective and cognitive states, have consistently emerged as influential components of customer behaviour and experience, frequently operationalized through attitudinal measures. The final outcome within the SOR paradigm is the behavioural response, influenced by the internal state, which can be categorized as approach or avoidance behaviors. Approach behaviors encompass positive actions directed towards a particular setting, such as positive communications or actions, while avoidance behaviors entail negative responses or disengagement.

In the context of sustainable marketing, the SOR model provides a comprehensive framework for understanding how different elements of the marketing mix can serve as stimuli that enhance the green brand image of fast fashion brands in Vietnam. For instance, sustainable product features, eco-friendly pricing strategies, green distribution practices, and environmentally conscious promotions can act as stimuli that trigger positive cognitive and affective responses in consumers. These responses, in turn, lead to favourable behavioural outcomes such as increased purchase likelihood, brand loyalty, and advocacy.

Furthermore, the cognitive evaluations of consumers regarding the sustainability of the brand (attitude) and their perceptions of normative social pressures to adopt green behaviors (subjective norm) significantly influence their behaviour. Studies by Chen *et al.* (2020) have shown that a strong green brand image can enhance consumers' positive attitudes towards the brand and align their behaviors with environmental values, thus increasing brand loyalty and market share.

Building on these theoretical foundations, this study aims to explore how sustainable marketing strategies can enhance the green brand image of fast fashion brands in Vietnam. By examining the role of various sustainable marketing mix elements and their impact on consumer perceptions and behaviors, the research seeks to provide insights into effective practices that can foster a positive green brand image and drive sustainable consumer behaviour in the fast fashion industry.

2.2.2. The concept of sustainable marketing mix

The marketing mix, as described by Kotler & Keller (2009), is a combination of tools used by enterprises to satisfy market demand for various goods or services within a specific market context and timeframe. Agic *et al.* (2016) further explain that marketing strategy involves the strategic integration of marketing tools to achieve organizational objectives within targeted market segments.

In examining the influence of a sustainable marketing mix on the green brand image within Vietnam's fast fashion industry, this study adopts the 4P model. These elements include:

Product. The product dimension refers to items designed or manufactured to meet specific demographic needs. Within the 4Ps marketing framework, a product can be tangible or intangible, encompassing both goods and services. This aspect is crucial as it directly impacts consumer decision-making; individuals tend to favour products that align with their environmental values. According to Ottman *et al.* (2006), consumers are increasingly inclined towards products that reflect sustainable practices, such as eco-friendly materials and ethical production processes. Therefore, enterprises must identify and respond to customer preferences regarding product attributes, enhancing quality to meet evolving market demands, and ultimately driving revenue growth (Kukanja *et al.*, 2016). Ensuring that designed and manufactured products align with current market needs and trends is essential to maintaining market relevance and competitive advantage.

Price. Price represents the monetary value customers must pay to acquire a product or service (Kotler & Keller, 2009). Effective competition and revenue growth require sound pricing strategies that reflect both the value proposition and the environmental benefits of the products. Pricing decisions play a pivotal role in revenue generation for enterprises, requiring a delicate balance between attracting customers and ensuring profitability to sustain competitiveness. According to Grubor & Milovanov (2017), sustainable pricing strategies can enhance a brand's green image by highlighting cost savings and environmental benefits. Price determination often involves considerations such as market segmentation and production costs, facilitating the establishment of optimal pricing structures for products and services.

Place. Another fundamental facet of the 4Ps Model, refers to the strategic locations for product display, introduction, and exchange. Effective revenue generation heavily relies on optimal distribution channels, necessitating accessibility for potential clients. This requires a deep understanding of market dynamics, as noted by Kushwaha & Agrawal (2015), where distribution decisions involve order handling, storage facilities, stock availability, and freight logistics. Sustainable distribution practices, such as reducing carbon footprints and optimizing logistics for minimal environmental impact, can further enhance the green brand image.

Promotion. This aspect is vital in marketing efforts, enhancing brand visibility and increasing sales. Effectively disseminating information about products and services is essential for raising consumer awareness. Enterprises engage in promotional activities through various communication channels, branding initiatives, and promotional strategies. Ensuring message consistency is crucial, attracting consumers to the business's offerings (Marques *et al.*, 2014). In the context of sustainable marketing, promotions should emphasize the brand's commitment to environmental sustainability, leveraging green certifications and eco-labels to build credibility and trust (Dangelico & Vocalelli, 2017).

2.3. Hypothesis development

Existing literature suggests a significant relationship between sustainable product strategies and green brand image in consumer perception. Mahmoud (2017) identified a direct positive correlation between green product offerings and green brand image among a sample of 341 university students. This finding is further supported by Wanninayake & Randiwela (2008), who emphasized the positive influence of sustainable product structures and eco-friendly packaging on consumer perception of green brand image. Additionally, Bathmathan & Rajadurai (2019) found a significant impact of sustainable products on green brand image among Generation Y consumers, considering the broader marketing mix. These results are consistent with the findings of Sembiring (2021) and Nindya & Aditia (2022). Based on this body of evidence, the following hypothesis is proposed ***H1a: Sustainable product strategy positively influences green brand image.***

Existing literature consistently demonstrates a positive relationship between sustainable pricing strategies and green brand image (Ansar, 2013; Widyastuti *et al.*, 2020; Dewi, 2023). Pushpanathan (2020) highlights the importance of pricing as a key determinant in shaping consumer perception of a brand's green image, particularly in the Indonesian food and beverage industry where it influences 14% of customer perceptions. Similarly, Geap (2018) reported a positive association between sustainable pricing strategies and green brand image among Malaysian university students. This finding is further supported by Saraswati & Wirayudha (2022), who confirmed the significant impact of sustainable pricing on green brand image. Based on this evidence, the following hypothesis is posited ***H2a: Sustainable price strategy positively influences green brand image.***

Mahmoud (2020) found that green distribution significantly influences the green brand image among university students. This aligns with previous research by Bathmathan & Rajadurai (2019) showing a positive impact of green distribution on Gen Y's perception of green brand image in Malaysia, ranking second only to green products. Pushpanathan (2020) also confirmed that eco-friendly locations positively affect the green brand image, regardless of individual factors like age or income. Mamahlit's (2015) study on Ades bottled water further supports these findings, concluding that sustainable distribution strategies directly and positively impact the green brand image. Therefore, the research hypothesis proposes ***H3: Sustainable place strategy has an impact on green brand image.***

Research on green communication strategies' impact on green brand image consistently shows positive effects. Studies by Mamahit (2015), Geap *et al.* (2018), Mahmoud (2018), Bathmathan & Rajadurai (2019), Karunarathna *et al.* (2020), and Pushpanathan (2020) support this notion. Geap *et al.* (2018) emphasize the significant influence of green communication strategies, particularly through advertising, in attracting environmentally conscious customers. Pushpanathan's (2020) findings further reinforce this, indicating a reliable 5% impact of communication factors on green brand image. Hence, the authors propose the following hypothesis: ***H4: Sustainable promotion strategy has a positive impact on green brand image.***

These aforementioned proposed hypotheses can be illustrated in the following research model.

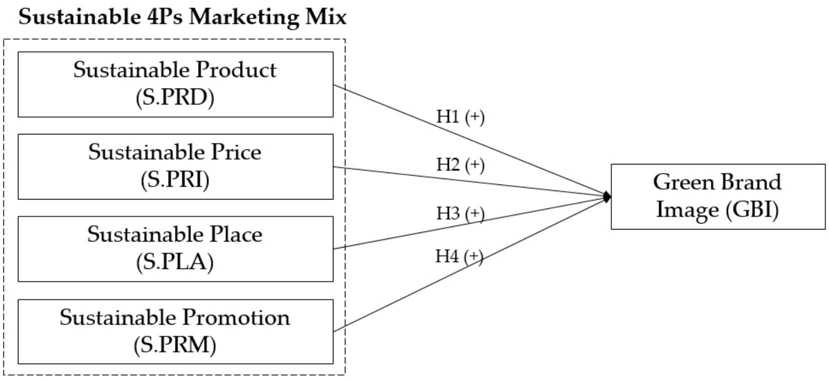

Figure 1: Proposed research model

Source: Authors' compilations, 2024

3. Methodology

3.1. Questionnaire development

The current study utilized a 5-point Likert scale to measure the observed variables, adopting and adapting the measurement scales from prior research. The "Sustainable product strategy" scale was assessed through 4 observed variables, drawing on the works of Santoso & Fitriyani (2016), Ghodeswear (2015), Rokka & Usitalom (2008), and Pankaj & Vishal (2014). The "Sustainable pricing Strategy" scale was informed by Hossain & Khan (2018), Nindya Saraswati *et al.* (2022), and Hashem & Alrifai (2011). For the "Sustainable place strategy" scale, the researchers employed variables from Kaur *et al.* (2022), Vlosky *et al.* (1999), and Martin & Schouten (2012). The "Sustainable promotion strategy" scale utilized 4 observed variables derived from the works of Awan (2011), Zaremohzzabieh *et al.* (2014), and Hashem & Alrifai (2011). Finally, the "Green brand image" variable was measured using a modified version of Armitage & Conner's (2001) scale.

3.2. Data collection

Table 1: Descriptive statistics

Characteristic		Frequency	Percent	Characteristic		Frequency	Percent
Gender	Male	354	51,2	Purchase frequency	Less than once a month	30	4,3
	Female	338	48,8		Once a month	240	34,7
Age	18-22	242	35		2-3 times a month	308	44,5
	23-26	298	43,1		4-6 times a month	114	16,5
	27-30	152	22	Monthly spending amount (VND)	<300,000	92	13,3
City	Hanoi	294	42,5		300,000 – 500,000	256	37
	HCMC	152	22		500,000 – 1,000,000	238	34,4
	Other	246	35,5%		>1,000,000	106	15,3%

Source: Authors' calculations (2024)

Data were collected using a convenience sampling approach via a Google Forms questionnaire. The questionnaire was administered to Vietnamese consumers aged 18 to 30 between January 10th and February 10th, 2024. As detailed in Table 1, the study yielded 692 valid responses.

4. Empirical results

4.1. Cronbach's Alpha test of reliability and Exploratory Factor Analysis (EFA)

To evaluate reliability, the Cronbach's Alpha (CA) coefficient was employed, followed by the use of EFA (with the Principal Component Analysis and Varimax Rotation), which is the used in the Confirmatory Factor Analysis (CFA). The outcomes of both tests are presented in Table 2.

The EFA results reveal that the observed variables of the independent variables converge into 4 factors, namely S.PRD, S.PRI, S.PLA, and S.PRM, with factor loadings all exceeding 0.5. The Cronbach's Alpha coefficients of all scales are equal to or greater than 0.7, indicating strong internal consistency. Additionally, the variable-to-total correlations of the observed variables are all above 0.3. These thresholds are taken from Hair *et al.* (2014).

Table 2: Cronbach's Alpha reliability scale and EFA results

Scale	Observed variable	CA if deleted	Item-Total	Factor Loading
Cronbach's Alpha of S.PRD = 0.943				
S.PRD1	The product is made from high-quality ingredients.	0.928	0.855	0.892
S.PRD2	The brand has limited the use of packaging materials.	0.927	0.858	0.897
S.PRD3	The product is reusable multiple times.	0.925	0.862	0.799
S.PRD4	The product has minimal impact on the environment.	0.920	0.886	0.779
Cronbach's Alpha of S.PRI = 0.910				
S.PRI1	I find the price commensurate with the product quality.	0.855	0.839	0.833
S.PRI2	I find the product to be reasonably priced.	0.868	0.823	0.846
S.PRI3	The price includes contributions to the environment and society.	0.889	0.801	0.824
Cronbach's Alpha of S.PLA = 0.830				
S.PLA1	The product is widely distributed.	0.777	0.678	0.750
S.PLA2	The brand uses environmentally friendly transportation methods.	0.750	0.733	0.833
S.PLA3	The locations of the stores are sustainable.	0.801	0.624	0.689
S.PLA4	The stores utilize resources sustainably.	0.811	0.600	0.703
Cronbach's Alpha of S.PRM = 0.803				
S.PRM1	Advertising campaigns emphasize social and environmental factors.	0.751	0.625	0.800
S.PRM2	Communication campaigns provide sufficient information about the social benefits of purchasing the product.	0.763	0.599	0.778
S.PRM3	Communication campaigns provide information about the sustainability of the product.	0.777	0.571	0.751
S.PRM4	The communication campaigns focus on sustainable messages.	0.723	0.680	0.833
Cronbach's Alpha of GBI = 0.803				
GBI1	I believe the brand is a leader in sustainable fashion.	0,815	0,718	
GBI2	I trust the brand's commitment to sustainability.	0,834	0,643	
GBI3	The brand has a positive green image.	0,815	0,713	
GBI4	The brand stands out as an environmentally responsible company.	0,844	0,617	
GBI5	I consider the brand a good example of sustainable fashion.	0,823	0,689	

Source: Authors' compilations and calculations (2024)

4.2. Confirmatory Factor Analysis (CFA)

After determining correlation between constructs with high Modification Indices, the model fit indices are as follows: CMIN/df = 1.662 (Between 1 and 3), CFI = 0.982 (>0.95), SRMR = 0.045 (<0.08), TLI = 0.977 (>0.9), RMSEA = 0.044 (<0.06), and PClose = 0.856 (>0.05). According to Hu & Bentler

(1999) and Hair *et al.* (2014), these indices indicate an acceptable model fit and provide sufficient conditions to proceed with further analysis.

Then, the model goes under a convergent and discriminant validity test (using the Master Validity plugins - Gaskin & Lim (2016), with results in Table 3. The CR exceeding 0.7 and AVE exceeding 0.5 confirm the convergence of each variable (Hu & Bentler, 1999). In terms of discriminant, according to Fornell & Larker (1981) and Hu & Bentler (1999), the two conditions are (i) MSV < AVE and (ii) SQRAVE < Inter-Construct Correlation, which are all met, rendering the data suitable and eligible for using Structural Equation Modeling (SEM). The standardized result of CFA is presented in Figure 2.

Table 3: Master Validity results

	CR	AVE	MSV	MaxR(H)	GBI	S.PRD	S.PLA	S.PRI	S.PRM
GBI	0.911	0.683	0.165	0.957	0.826				
S.PRD	0.927	0.764	0.402	1.046	0.291***	0.874			
S.PLA	0.833	0.557	0.361	0.840	0.406***	0.601***	0.746		
S.PRI	0.912	0.775	0.402	0.914	0.351***	0.634***	0.554***	0.880	
S.PRM	0.806	0.510	0.017	0.816	0.044	0.067	0.131*	0.123†	0.714

Source: Authors' calculations (2024)

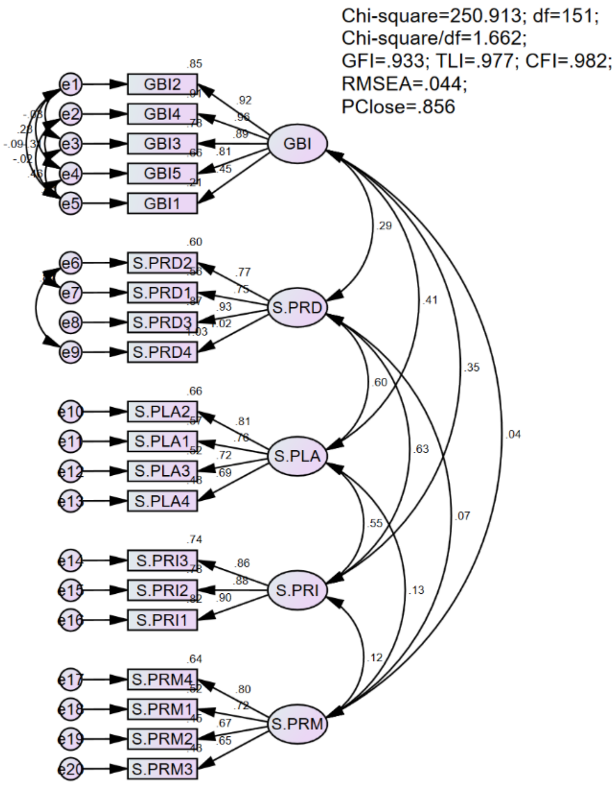

Figure 2: Standardized CFA results

Source: Authors' calculations (2024)

4.3. Hypotheses testing

The results of the model fit indices indicate that all indices meet the conditions required for hypothesis testing (Hair *et al.*, 2014). Specifically: CMIN/df = 1.662 (Between 1 and 3), CFI = 0.982 (>0.95), SRMR = 0.045 (<0.08), TLI = 0.977 (>0.9), RMSEA = 0.044 (<0.06), and PClose = 0.856 (>0.05). The standardized results of SEM is shown in Figure 3.

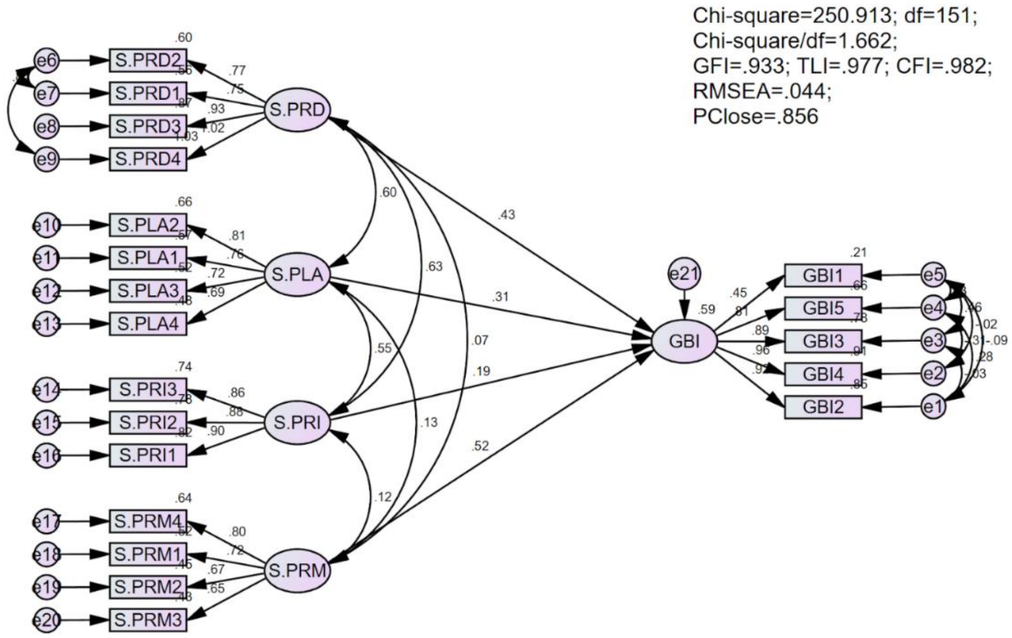

Figure 3: Standardized SEM results

Source: Authors' calculations (2024)

The model testing results indicate that the R^2 for the dependent variable is 0.592. This means that the independent variables S.PRD, S.PRI, S.PLA, and S.PRM collectively explain 59.2% of the variance in the dependent variable GBI.

Specifically, among four independent variables, the strongest impact is from S.PRM with $\beta_{GBI \leftarrow S.PRM} = 0.521$ ∗∗∗. This is followed closely by the impact of S.PRD with $\beta_{GBI \leftarrow S.PRD} = 0.432$ ∗∗∗. The third most influential is the S.PLA factor ($\beta_{GBI \leftarrow S.PLA} = 0.313$ ∗∗). Finally, S.PRI is in the fourth place with $\beta_{GBI \leftarrow S.PRI} = 0.194$ ∗. Therefore, all proposed hypotheses H1, H2, H3, and H4 are accepted.

5. Discussion and Conclusion

5.1. Discussion

Firstly, the research result indicates that sustainable promotional strategies significantly enhance the green brand image within Vietnam's fast fashion industry. When brands effectively communicate their commitment to sustainability through various advertising and promotional activities, consumers perceive these brands as more authentic and reliable. This heightened perception fosters greater trust and engagement, which subsequently enhances the green brand image. Fast fashion brands should therefore prioritize sustainable promotion strategies, emphasizing their environmental efforts to build consumer trust and loyalty.

Secondly, it highlights the importance of sustainable product strategies in shaping the green brand image. Products made from high-quality, eco-friendly materials and designed for reusability are highly favored by environmentally conscious consumers. By focusing on sustainable product development and clearly communicating these benefits, brands can align with consumer values and improve their green brand image. This approach not only attracts eco-conscious consumers but also strengthens brand loyalty and advocacy.

Thirdly, adopting sustainable place strategies, such as eco-friendly transportation methods and sustainable store practices, also positively influences the green brand image. Effective distribution practices that minimize environmental impact resonate well with consumers who prioritize sustainability. Fast fashion brands should therefore integrate green distribution practices into their operations to enhance their environmental reputation and appeal to eco-conscious customers.

Fourthly, while sustainable pricing strategies have a comparatively lower impact, they still contribute positively to the green brand image. Transparent pricing that reflects the environmental benefits and ethical considerations of products can attract consumers who value sustainability. Brands should develop pricing strategies that highlight their commitment to environmental responsibility, thus enhancing their appeal to eco-conscious consumers.

5.2. Managerial implications

Firstly, fast fashion brands should enhance their promotional strategies by emphasizing sustainability. Effective communication about eco-friendly initiatives through advertising can significantly boost the green brand image. Brands should leverage green certifications and sustainable messaging in their promotional activities to build credibility and trust.

Secondly, focusing on sustainable product strategies is crucial. Brands need to invest in the development of products that use eco-friendly materials and promote reusability. Clear communication of these sustainable product features can attract and retain environmentally conscious consumers, thereby strengthening the green brand image.

Thirdly, adopting sustainable place strategies is essential for enhancing the green brand image. Brands should implement eco-friendly transportation methods and sustainable store practices to reduce their environmental footprint. These green distribution practices can improve the brand's environmental reputation and appeal to sustainability-minded consumers.

Fourthly, implementing sustainable pricing strategies can also positively impact the green brand image. Brands should ensure their pricing reflects the environmental benefits and ethical considerations of their products. Transparent and sustainable pricing can attract consumers who prioritize environmental responsibility.

Lastly, a comprehensive approach integrating sustainability across all elements of the marketing mix is vital. Consistency in sustainable efforts across product development, pricing, distribution, and promotion will help build a robust green brand image. Future research should explore the impact of retail-level marketing activities in conjunction with manufacturer strategies to provide a more holistic understanding of sustainable marketing in the fast fashion industry.

5.3. Conclusion

The investigation has delineated the constructive influence of sustainable marketing initiatives adopted by fast fashion brands on green brand image. Furthermore, the research findings offer strategic insights into resource allocation for promoting sustainable consumer behavior through marketing endeavors. Nonetheless, it is imperative to acknowledge that this study exclusively concentrates on assessing the impact of marketing initiatives undertaken by manufacturers of fast fashion products on green brand image, without overlooking the marketing activities at the retail point of sale. Future research endeavors should endeavor to scrutinize the concurrent effects of marketing endeavors at retail establishments alongside the marketing and branding strategies employed by fast fashion product manufacturers on green brand image.

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The Roles of Green WOM and Purchase Intention in Green Marketing

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Abstract

This study examines the extent to which Green Brand Value, Customer Engagement, and Green Perceived Benefits impact the intention to purchase green products among Vietnamese consumers, with Green Word of Mouth (GW) acting as a mediator. A dataset comprising 265 responses was analyzed using Partial Least Squares Structural Equation Modeling (SEM). The findings reveal that Green Brand Value, Customer Engagement, and Green Perceived Benefits significantly influence Green Purchase Intentions. Additionally, GW strengthens these relationships. The study offers valuable insights into the behavior of green consumers in Vietnam, indicating that consumers are more likely to engage in green purchasing when they perceive strong brand value and benefits. Practical suggestions include emphasizing green brand equity, enhancing customer engagement, and promoting GW to reinforce green marketing strategies. This study contributes to a better understanding of the factors driving green purchase intentions in Vietnam's expanding green market.

Keywords: *Green brand equity, customer engagement, green perceived benefits, green word-of-mouth, green purchase intention*

1. Introduction

In the face of the exploitation and destruction of natural environments, the concept of "green consumption" has consistently been a hot topic, drawing significant attention worldwide. Consumers believe that their consumption choices can collectively contribute to protecting the environment and improving the quality of social life or help mitigate environmental degradation. This belief influences how they perceive and interact with marketed goods and services. Hence, there is a growing trend among enterprises to exhibit social accountability by resolving environmental dilemmas and decreasing reliance on non-renewable resources. This shift not only sparks consumer interest but also leads to the development of green marketing strategies. Green marketing, as defined by Genoveva & Levina (2019), includes various approaches such as green products, branding, packaging, advertising, pricing, and distribution. The use of these approaches is expected to significantly influence customer preferences towards the purchase of environmentally friendly items (Amalia et al., 2021)

Previous research has extensively explored green purchase intentions, both domestically and internationally. In a survey conducted from 870 consumers who purchased milk products in Vietnam, Nguyen-Viet (2022) found that green brand equity mediates the relationship between eco-labels and green advertising and green purchase intention, underscoring its critical role in enhancing consumer purchase decisions through environmental marketing strategies. Mouloudj & Bouarar (2021) concluded that word of mouth (WOM) significantly influences consumer purchase intentions for green products through direct effects and positively impacting environmental awareness and attitudes towards green products, thereby further enhancing purchase intentions. In addition to examining the impact of perceived value and eWOM on intention, (Nguyen et al., 2024) have demonstrated that electronic word of mouth (eWOM) significantly influences green purchase intention by enhancing perceived value and trust among consumers, thereby playing a crucial intermediary role in shaping purchasing decisions in Vietnam.

Despite these insights, there remains a need to further explore these dynamics in emerging markets like Vietnam, a rapidly growing green market in Asia (Willer & Lernoud, 2019). Specifically, it seeks to provide insights into the effectiveness of Green Brand Equity, Customer Engagement, Perceived Green Benefits, and Green Purchase Intentions, with Green WOM as a mediating variable within the context of consumers in Hanoi, Vietnam.

The structure of this study encompasses six sections: (i) introduction; (ii) literature review and research model; (iii) research method; (iv) results; (v) discussion; and (vi) limitations, future work, and conclusion.

2. Literature review and Hypothesis development

2.1. Green brand equity

There are many empirical studies shows that brand equity is the driver of the purchase intention. Aaker (2009) described brand equity as the collection of brand-related assets and liabilities—such as brand loyalty, brand awareness, perceived quality, and brand associations—that can either enhance or detract from the value of a product or service. This concept reflects the consumers' perception of the overall quality of a product bearing that brand name in comparison to competing brands. Building on this, Keller et al. (2010) introduced the notion of customer-based brand equity, which views brand equity from the consumer's perspective. According to Keller et al.(2010), brand equity as the "added value of a brand that forms part of a product created in the minds of consumers in response to past investments in the brand's marketing." Green brand equity, according to Y.-S. Chen (2010), is a collection of the advantages and disadvantages of the company's environmental commitment and environmental concerns connected to the brand, brand names, and symbols that have the power to raise or lower a product or service's value. Customer satisfaction and trust are built by-products that are perceived as environmentally friendly and care for the environment. So, environmentally friendly brand equity is determined by how consumers perceive an eco-friendly brand and how much the value of environmental principles can add to the brand. Based on the above-mentioned matters, the hypothesis of the research is raised as follows:

H1. Green brand equity has a significant impact on Green purchase intention

2.2. Customer engagement (CE)

Customer engagement has been examined across various academic disciplines, including sociology, political science, psychology, and organizational behavior. Researchers have compiled and summarized the definitions of engagement from these diverse fields (see Table 1)

Table 1: Definitions of Customer Engagement

Authors	Definition
Brodie et al. (2011)	CE is a psychological state that occurs through interactivity and cocreation of customer experience with a focal agent/object (e.g., a brand) in a focal service relationship.
Van Doorn et al.(2010)	CE is a customer's behavioral manifestations that have a brand or a firm focus, beyond purchase, resulting from motivational drivers
Hollebeek at al. (2011)	CE is a psychological process that simulates the underlying processes by which customer loyalty builds for new consumers of a service brand as well as the methods by which loyalty may be maintained for repeat purchase customers of a service brand
Abbas et al. (2018)	CE is consumer actions that are directed toward certain businesses or brands for reasons other than simple consumption. It has to do with clients developing close emotional ties to the brand
Husnain and Toor (2017)	CE has been linked to both usage intention and customer loyalty.
Harmeling et al. (2017)	CE involves the firm's deliberate efforts to motivate, empower, and assess customers' voluntary contributions to its marketing functions, extending beyond core economic transactions.

Source: Author

The characteristics of CE, as detailed by the authors in Table 1, align with a multidimensional framework encompassing cognitive, behavioral, and emotional involvement with a product or brand. Numerous studies across various fields have explored the relationship between customer engagement and purchase intention. In the online travel agent industry, research by Putra et al. (2020) revealed that customer engagement significantly influences purchase intention, with factors like social influence, interaction, and information sharing on social media playing crucial roles in boosting engagement and driving purchase decisions. Similarly, Rodrigues De Matos et al. (2023) discovered that consumer engagement strongly affects the purchase intention of ecological products, as highly engaged consumers perceive greater value in these products, increasing their likelihood of purchase. When customers feel connected to causes, they care about and hold favorable opinions, their engagement with green activities and brands rises, which in turn enhances their green purchase intention (Joshi & Srivastava, 2019). Thus, we posit:

H2. Customer engagement has a significant impact on Green Purchase Intention.

2.3. Green perceived benefits (GPB)

Perceived benefit is seen to be one of the key factors influencing a customer's purchase decision. Consumers tend to maximize the value they obtain by comparing perceived costs to perceived value and choosing products that offer the greatest perceived benefit (Grimmer & Woolley, 2014). Green perceived benefit is "a consumer's overall appraisal of the net benefit of a product or service between what is received and what is given based on the consumer's environmental desires, sustainable expectations, and green needs," according to Patterson & Spreng (1997). The General Perceived Value (GPV) theory has been further explored in various studies, which have dissected its components and applied structural equation modeling to examine the relationships involved. For instance, Y. Chen & Chang (2012) developed a hypothesis demonstrating that GPV significantly influences green purchase intentions. Similarly Lam et al. (2016) identified perceived benefit as a strong predictor of consumer motivation to repurchase green products. Conversely, low perceived value can reduce consumer purchase intentions (Sweeney & Soutar, 2001). Thus, to enhance consumers' willingness to repurchase green products, companies should focus on improving these attributes. In the current era of environmentalism, green perceived benefit is critical to green purchase intentions, leading to the following hypothesis:

H3. Green perceived benefits have a significant impact on Green Purchase Intention.

2.4. The mediating role of green WOM (GW)

A. Chen & Peng (2014) define Green Word-of-Mouth (GW) as the extent to which consumers transfer positive or negative environmental signals to friends, family, and coworkers. The power of GWOM can significantly influence marketing strategies, as it affects consumers' attitudes and behaviors toward green products (Y. Chen & Chang, 2013). Due to its substantial impact, GW is a valuable tool for attracting environmentally conscious consumers. Previous studies have shown that consumers' strong emotional attachment to a green brand led to both recommendations and purchases of green products. Mohd Yasin et al. (2007) argue that high brand equity can shift consumer attitudes, making those with a positive green outlook more inclined to purchase green products. Furthermore, Y. Chen & Chang (2013) found that positive GW enhances purchase intentions, while Y.-S. Chen et al. (2014) discovered that consumers are more likely to trust and buy green products when influenced by strong GW, especially when uncertain about the products' green attributes. Similarly, Bekk et al. (2016) noted that customers form more favorable opinions of brands they perceive as genuine green symbols. Companies can also leverage social media to encourage customers to share positive experiences with their eco-friendly products, thereby promoting GW (Du et al., 2010). Based on these results, the study suggests that building green brand equity and perceived benefits can change consumers' perceptions of green brands and encourage them to recommend them to others. In the context of this discussion, the following theories are put forth:

H4a. Green Word-of-Mouth mediates the relationship between Green brand equity and Green Purchase Intention.

H4b. Green Word-of-Mouth mediates the relationship between Green's perceived benefits and Green Purchase Intention.

H4c. Green Word-of-Mouth mediates the relationship between Customer engagement and Green Purchase Intention.

2.5. Green purchase intention (GPI)

Purchase intention is the desire of the people to get the things they want by purchase it. In this case, people or the customers will put their effort to purchase it and usually it affected by their behavior. Consumer's purchase intention toward green product which used to call as green purchase intention is conceptualized as the probability and willingness of a person to give preference to products having eco-friendly features over other traditional products in their purchase considerations. According to Y. Chen & Chang (2012) , green purchase intention also includes the price consumers are willing to pay for environmentally friendly goods or services. Studies by Ahmad & Zhang (2020) and Nia et al. (2018) further conceptualize green purchase intention as the interest, desire, and likelihood that a consumer will choose environmentally friendly products. Additionally, previous research has established the relationship between green purchase intention and factors such as green brand equity, green perceived value, customer engagement, and green word-of-mouth. Therefore, our research model is as follows (Figure 1).

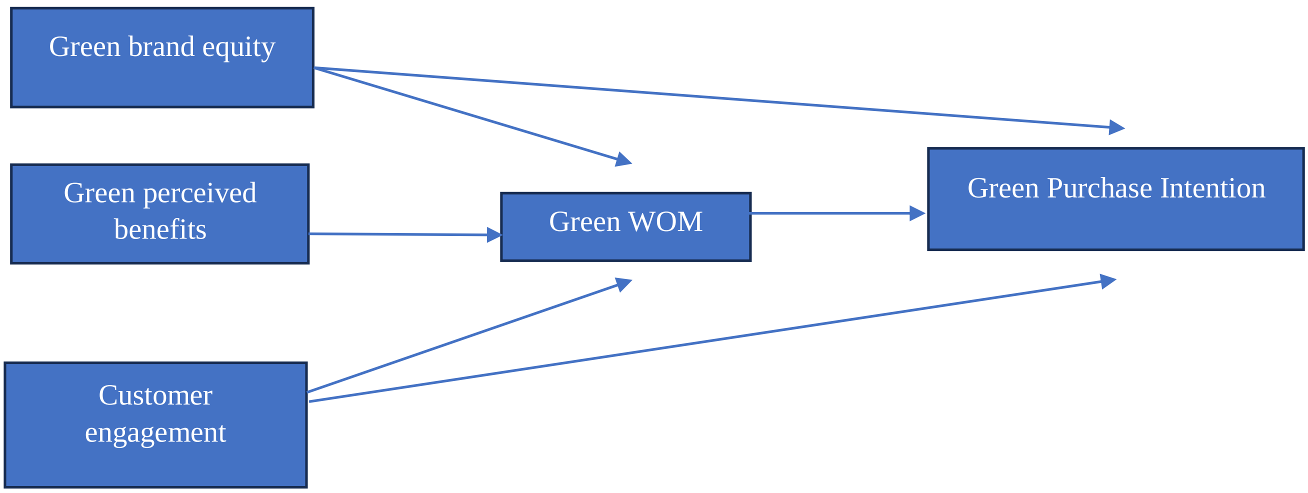

Figure 1: Research framework

Sources: Authors

3. Methods

3.1. Approach and sample

This study explores the causal relationships between the proposed concepts, focusing on the impact of Green Brand Equity, Customer Engagement, and Green Perceived Benefits on Green Purchase Intention, with Green Word-of-Mouth acting as a mediating variable. The research population was consumers of green products in Hanoi, Vietnam. The research population consisted of 350 people, and 265 valid responses were obtained (see Table 2) since the other 85 responses were incomplete or inappropriate.

This study looks at green products, which are eco-friendly and aim to reduce environmental harm and support sustainability. These products cover many areas, like household items, cosmetics, clothing, and food... During data gathering, organic products were used instead of green products, possibly confusing respondents who thought of organic products mainly as food. In this study, organic products are seen as a specific type of green product, showcasing eco-friendly items with particular environmental advantages.

A non-probabilistic sampling method by quotas was used, ensuring a diverse representation of age and gender. Data were collected through a self-administered online questionnaire over one month. Ethical protocols were strictly followed to ensure the anonymity of respondents and the reliability of their answers. The questionnaire was divided into two sections. The first section included demographic questions about the respondents, such as gender, age, occupation, place of purchase, and purchase frequency (see Table 2). The second section of the questionnaire included scales for measuring the variables proposed in the study model.

Table 2: Demographic profile of the respondents

Demographic Profile	Frequency	%
Gender		
Male	93	35.1
Female	172	64.9
Age		
Under 18	4	1.5
18 to 25 years old	129	48.7
26 to 35 years old	89	33.6
36 to 45 years old	36	13.6
46 and over	7	2.6
Occupation		
Student	80	30.2
Employee	119	44.9
Self-employed	58	21.9
Unemployed or retired	8	3.0
Place of purchase		
Eco-fair	53	20.0
Specialised shops	84	31.7
Online websites of specialized shops or supermarkets	49	18.5
Supermarkets	79	29.8
Frequency of purchase		
Weekly	45	17.0
More than once a month	53	20.0
Monthly	120	45.3
Infrequently	47	17.7

Source: Survey data (2024)

3.2. Measures

The measures utilized in this study were adapted from established scales in previous literature, ensuring the validity and reliability of the examined constructs. Most variables were measured on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree," and were operationalized using multiple items to capture the complexity of each construct. Green Brand Equity was assessed using a five-item scale based on the work of Hue & Oanh (2023), which has been widely recognized in the field of green marketing. Customer Engagement was measured using a five-item scale derived from Li & Nuangjamnong (2022). Green Perceived Benefits were operationalized through a five-item scale, which was adapted from Doszhanov & Ahmad (2015). Green Word-of-Mouth was measured using a four-item scale adapted from Ahmad & Zhang (2020). Green Purchase Intention was assessed through a six-item scale based on the studies of Ahmad & Zhang (2020). All the scales used in this study were selected and adapted from previous research to fit the context of green consumer behavior. The items were pretested with a small sample to ensure clarity and appropriateness before being used in the complete survey. This approach ensured that the measures were reliable and valid for assessing the constructs of interest in this study.

4. Results and Discusion

Structural Equation Modelling (SEM) using Smart PLS was conducted to analyze the data. The reliability and validity of the constructs were first assessed through the measurement model, followed by hypothesis testing using the structural model. Mediation analysis was also performed using Preacher and Hayes's method, which included a bootstrapping procedure with 5,000 subsamples to calculate T-values and confidence intervals (Preacher & Hayes, 2008). PLS-SEM was chosen due to its suitability for exploratory research and its effectiveness in predicting relationships between constructs (Hair et al., 2019).

Table 2 presents the socio-demographic characteristics of the sample. The sample comprised 265 respondents, of which 93 (35.1%) were male and 172 (64.9%) were female. The respondents were predominantly aged between 18 to 25 years old (48.7%), followed by those aged 26 to 35 years old (33.6%), with smaller percentages in the under 18 (1.5%), 36 to 45 years old (13.6%), and 46 and over (2.6%) age groups. Notably, most respondents were employees (44.9%), followed by students (30.2%), self-employed individuals (21.9%), and a small percentage of unemployed or retired individuals (3.0%). Regarding purchasing habits, 31.7% of respondents purchased green products from specialized shops, 29.8% from supermarkets, 20.0% from eco-fairs, and 18.5% from online websites of specialized shops or supermarkets. Regarding purchase frequency, 45.3% reported purchasing green products monthly, while 20.0% bought more than once a month, 17.0%

4.1. Measurement model

The reliability and validity of the model were evaluated using a measurement model, following the guidelines (Hair et al., 2019). Composite reliability was used to assess the reliability of all constructs, with the minimum value observed being 0.869, which exceeds the standard threshold of 0.7 (Hair et al., 2019). Most scale items showed acceptable loading values over 0.7. Some items such as, CE3, CE4, GBE2, GBE3, GBE5, GPI1, GPI2, GPI4, GPI5, GW3 was removed due to significantly low loading. Convergent validity was confirmed through the Average Variance Extracted (AVE), with all constructs showing AVE values above the 0.5 minimum threshold (Hair et al., 2019). Table 3 details the items' loadings, AVE, and composite reliability.

Table 4 presents the results for the heterotrait-monotrait ratio (HTMT) criterion, which was used to evaluate the discriminant validity of the constructs. Following the guidelines by (Henseler et al., 2015), an HTMT value below 0.90 indicates acceptable discriminant validity. With this criterion met, the next step involved assessing the structural model.

Table 3: Reliability and validity

Measures		OL	CR	AVE
Customer engagement (CE)			0.869	0.689
CE1	I often browse the news posts about the green product on social media channels or brands' official website	0.841		
CE2	I often join the activities organized by green brands from both online and offline	0.818		
CE5	I say positive things about green product or brand to others	0.832		
Green brand equity (GBE)			0.875	0.778
GBE1	The brand is of high quality	0.883		
GBE4	The green functions of this brand satisfy my expectations	0.881		
Green perceived benefits (GPB)			0.888	0.613
GPB1	The product's environmental functions provide very good value for me	0.785		
GPB2	The product's environmental performance meets my expectations	0.795		
GPB3	I purchase a product because it has more environmental concerns than other products	0.77		

Measures		**OL**	**CR**	**AVE**
GPB4	I purchased a product because it is environmentally friendly	0.77		
GPB5	I purchase products because it has more environmental benefits than other products	0.794		
Green Purchase Intention (GPI)			0.87	0.771
GPI3	I intend to buy organic products because of their environmental impact and health benefits.	0.879		
GPI6	I will buy organic products when I need to buy healthy things	0.877		
Green WOM (GW)			***0.877***	***0.705***
GW1	Due to their eco-friendly and healthy image, organic products are recommended by other people	0.841		
GW2	Due to their environmental and health benefits, organic products are positively recommended by other people	0.84		
GW4	Due to their environmental and health benefits, organic products receive positive feedback from people	0.838		

Source: Author

Table 4: Discriminant validity of measurement model – HTMT

	Green purchase intention	Customer engagement	Green WOM	Green brand equity
Green purchase intention_				
Customer engagement	0.847			
Green WOM	0.524	0.556		
Green brand equity	0.494	0.546	0.899	
Green perceived benefits	0.496	0.44	0.422	0.476

Source: Author

4.2. Structural model

The structural model in this study was assessed using T-values, effect sizes (f2), and the coefficient of determination (R2) (Hair et al., 2019). A bootstrapping technique with 5,000 samples was used to calculate the T-values (Hair et al., 2019). The results show that the impact of GBE on GPI (H1) is significant, with a coefficient (b) of -0.177 and a p-value less than 0.01. Similarly, the influence of CE on GPI (H2) is also supported, with a coefficient (b) of 0.379 and a p-value below 0.01. GPB impact on GPI (H3) is likewise significant, with a coefficient (b) of -0.397 and a p-value less than 0.01.

For the mediation analysis shown in Table 6, the relationship between CE and GPI is positively mediated by GW, as reflected by a significant coefficient (B = 0.098), a T-value of 3.531, and a p-value of 0.000, with a 95% confidence interval [0.05, 0.16], confirming the support for H4c (Preacher & Hayes, 2008). Similarly, the negative relationship between GBE and GPI is mediated by GW, with a coefficient (B = -0.094), a T-value of 3.517, and a p-value of 0.000, within a 95% confidence interval [-0.153, -0.048], supporting H4a (Preacher & Hayes, 2008). Additionally, GPB positively influences GPI through GW, as indicated by a significant coefficient (B = 0.083), a T-value of 3.414, and a p-value of 0.001, with a confidence interval [0.042, 0.139], supporting H4b (Preacher & Hayes, 2008). These findings underscore the crucial mediating role of Green Word-of-Mouth in enhancing the impact of Customer Engagement, Green Brand Equity, and Green Perceived Benefits on Green Purchase Intention.

Furthermore, predictive relevance in PLS-SEM was evaluated using the Q^2 value, which was found to be 0.432, indicating predictive relevance since it is greater than zero. The effect sizes (f^2) are categorized as weak, moderate, and strong based on the values of 0.02, 0.15, and 0.35, respectively. The actual values obtained from the analysis are detailed in Table 5.

Table 5: Results of structural model analysis (hypotheses testing)

Hypothesis	Relationships	B	SE	T-values	P Values	F^2	Q^2	Decision
H2	CE -> GPI	0.379	0.063	5.994	0.000	0.152	0.432	Accepted
H1	GBE -> GPI	-0.177	0.061	2.914	0.004	0.033	0.432	Accepted
H3	GPB -> GPI	-0.397	0.058	6.884	0.000	0.181	0.432	Accepted

Source: Author

Table 6: Mediation analysis

	Relationships	B	SE	T-values	P Values	Confidence interval 95%		Decision
						2.50%	97.50%	
H4c	CE -> GW -> GPI	0.098	0.028	3.531	0.000	0.05	0.16	Accepted
H4a	GBE -> GW -> GPI	-0.094	0.027	3.517	0.000	-0.153	-0.048	Accepted
H4b	GPB -> GW -> GPI	0.083	0.024	3.414	0.001	0.042	0.139	Accepted

Source: Author

Further analysis reveals that Customer Engagement (CE) has the highest positive effect on Green Purchase Intention (GPI), with a path coefficient of 0.379, followed by Green Perceived Benefits (GPB) with 0.083. Interestingly, Green Brand Equity (GBE) had a negative mediation impact on GPI, with a coefficient of -0.094, suggesting that high brand equity may enhance consumer suspicion when environmental claims lack credibility, often linked to concerns of greenwashing. These findings highlight that, while brand equity is crucial, marketers should prioritize customer engagement and effectively communicate the products' environmental benefits. To enhance Green Purchase Intention and avoid over-reliance on brand value, decision-makers should emphasize these areas.

4.3. Discussion

The results of this study demonstrate strong support for the proposed hypotheses. The mediation analysis confirmed that Green Word-of-Mouth (GW) significantly mediates the effects of Customer Engagement (CE), Green Brand Equity (GBE), and Green Perceived Benefits (GPB) on Green Purchase Intention (GPI). Specifically, Customer Engagement was found to positively influence Green Purchase Intention through Green Word-of-Mouth, while Green Brand Equity had a negative impact on Green Purchase Intention when mediated by Green Word-of-Mouth. Furthermore, Green Perceived Benefits positively affected Green Purchase Intention via Green Word-of-Mouth. These results underscore the crucial role of Green Word-of-Mouth in shaping consumer behavior toward purchasing green products (Zhang et al., 2018; Wu & Chiang, 2023).

The findings align with existing literature on the role of Green Word-of-Mouth in influencing Green Purchase Intention, particularly in the context of Customer Engagement and Green Perceived Benefits. Previous research has also identified Green Word-of-Mouth as a potent mediator that enhances the positive effects of customer engagement on green purchasing behavior (Wu & Chiang, 2023;Guerreiro & Pacheco, 2021;Aravindan et al., 2023). However, this study diverges from some prior findings regarding Green Brand Equity. While earlier studies typically suggest that high brand equity positively influences purchase intentions, the negative mediation effect found here through Green Word-of-Mouth indicates a potential backlash or skepticism among consumers, possibly due to concerns about "greenwashing"(Pimonenko et al., 2020; Guerreiro & Pacheco, 2021; Zhang et al., 2018). This contrast highlights the nuanced role that Green Word-of-Mouth can play, particularly in the context of brand equity and consumer trust in green products.

The differences observed in the effect of Green Brand Equity on Green Purchase Intention, particularly the negative mediation through Green Word-of-Mouth, may be attributed to rising consumer awareness and skepticism towards greenwashing practices. In contrast to earlier studies that often highlight the positive impact of strong brand equity, this study suggests that when consumers perceive a brand as engaging in superficial environmental claims, it can lead to negative word-of-mouth and decreased purchase intention(Guerreiro & Pacheco, 2021; Zhang et al., 2018). This finding underscores the importance of genuine and transparent brand environmental practices, as consumers are increasingly discerning and vocal about authenticity in green marketing. This detailed understanding contributes to the current literature by revealing the potential downside of brand equity in the context of green consumer behavior(Qayyum et al., 2022; Amer & Ezz, 2023).

5. Conclusion, Implications, Limitations, and Future work

5.1. Conclusion

The research has resulted in multiple significant outcomes that enhance the comprehension of green consumer behaviors. To begin with, the study explained that Green Word-of-Mouth acts as a pivotal mediator in the relationships between Customer Engagement, Green Brand Equity, Green Perceived Benefits, and Green Purchase Intention. More precisely, the positive effect of Customer Engagement and Green Perceived Benefits on Green Purchase Intention via Green Word-of-Mouth highlights the crucial role of actual customer involvement and the perception of environmental advantages in promoting sustainable purchasing behavior.

Moreover, the research indicated an interesting negative mediating influence of Green Brand Equity on Green Purchase Intention, suggesting that increased brand equity could trigger consumer doubt in certain situations. This effect becomes particularly pronounced when environmental assertions are regarded as lacking in authenticity or sincerity. This result challenges the common idea that brand equity always strengthens consumer intentions, highlighting the essential requirement for integrity in green marketing activities.

In conclusion, this inquiry not only supports existing theoretical frameworks concerning consumer engagement and perceived benefits but also sheds light on novel understandings of the complex interaction between brand equity and consumer trust. These findings emphasize the necessity of aligning consumer perceptions with brand authenticity when developing strategies for green marketing.

5.2. Implications

The findings obtained from this particular study bear notable implications for both theoretical development as well as practical application in the field of green marketing. In terms of theory, the research aims to expand the current knowledge by questioning the traditional assumption that strong brand equity always leads to positive consumer outcomes. Observing a negative mediating influence of Green Brand Equity on Green Purchase Intention via Green Word-of-Mouth fosters a deeper understanding of consumer skepticism, especially relevant amid perceptions of greenwashing. This indicates that future theoretical frameworks ought to factor in variables such as consumer trust and perceived authenticity when evaluating the effects of brand equity within green marketing environments (Chua et al., 2024).

From an application perspective, the research delivers valuable information for enterprises and marketers who aspire to refine their approaches to green marketing strategies. The beneficial effect of Customer Engagement and Green Perceived Benefits on Green Purchase Intention emphasizes the need to proactively involve consumers explaining the actual environmental benefits of the products available. Marketers must prioritize building authentic relationships with consumers and guarantee the credibility and transparency of their environmentally-focused statements (Alyahia et al., 2024). These approaches are crucial for strengthening consumer trust and leveraging Green Word-of-Mouth as a powerful tool to influence purchase intentions.

Managers should be cautious in how they communicate brand equity, particularly when it comes to environmental claims. Companies should focus on making their green initiatives impactful and appealing to the discerning consumer base instead of solely relying on brand strength (Salnikova et al., 2022). This will help reduce the risks of negative word-of-mouth and improve the effectiveness of green marketing efforts.

5.3. Limitations

While this study offers insights worth noting, its limitations should be acknowledged as well. Firstly, the use of self-reported data may have caused response bias since participants could have exaggerated their involvement with friendly products or their intentions to make purchases. Furthermore, the cross-sectional design of the study restricts the ability to make causal connections between the variables under scrutiny. One issue to consider is the size of the sample used in this study. It might not accurately reflect the entire population out there and could limit how broadly the findings can be applied to others These findings mainly looked at things like Green Word of Mouth and Green Purchase Intention without giving weight to factors like cultural background or economic status which can also play a big role, in how consumers behave.

5.4. Future research

Considering the limitations of this study, many suggestions for future research could be provided. In this regard, we wish to highlight that more research needs to be conducted to better understand the causal relationships between Green Brand Equity, Customer Engagement, and Green Purchase Intention. One simple next step with the investigation presented in this work would be to investigate these relationships longitudinally to better understand the interaction over time between the variables. Future research should also examine a more diverse and representative sample so as to enhance the generalizability of these findings. For example, it would be interesting to examine the influence of cultural and socioeconomic factors on green consumer behavior, as these aspects may influence the effectiveness of green marketing. Future research may also examine in more detail how other possible mediators, such as consumer trust and environmental awareness, may better explain the link between brand equity and purchasing intention.

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A Research on the Three Dimensions of Supply Chain Performance: An Impact of Sustainable Supply Chain Practices and Sustainable Supply Chain Inhibitors in Vietnamese Corporations

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Abstract

Sustainable is the new approach of modern organization and has emerged globally as a new tool to enhance corporate competitiveness. Despite this rise of sustainability impact in different aspects of management, research effort in Vietnam on this trend remains limited. Therefore, to fill in this gap, based on the Triple Bottom Line framework, this paper aims to investigate how SC performance is influenced by the impact of SSC practices, and SSC inhibitors in the context of Vietnam. The data of this study was collected from 258 firms with sustainability practices. Participants at each company were picked based on their knowledge and experience in SC management-related and sustainability-related occupations. The research results showed that SSC Inhibitors have no impact on any dimension of SC performance, and also do not affect SSC practices. On the contrary, SSC practices impose a positive direct impact on all three dimensions of SC performance, with the strongest influence on environmental dimension, followed by social performance and economic performance, respectively. These findings are in line with some previous studies but contradict with other previous research as the published results of these relationships are still mixed. The paper suggests a focus on implementing environmental management systems such as ISO14001, knowledge management development in Vietnamese enterprises, and further exploration on the impact of top management support and the division of SSC Practices into smaller dimensions for future research of the same topic.

Keywords: *Supply chain performance (SCP), sustainable supply chain inhibitors (SSCI), sustainable supply chain practices (SSCP), Triple Bottom Line (TBL)*

1. Introduction

Economic benefit such as profitability is the primary goal of any business, which is to sustain itself, invest in future growth and innovation, and gain a competitive advantage. Most traditional companies would emphasize greatly in keeping their profit level and improve it overtime to reach a certain level of sustainable increase of their economic benefit. However, pressing environmental issues, including climate change, carbon dioxide emission, prolonged social problems involving workers' conditions, minority development… forcing modern businesses to shift towards a more sustainable approach to hold stakeholder recognition and public image (Schaefer, 2004). According to Standard Chartered Bank (2023), 65% of respondents among 300 companies assume that being more sustainable helps their business be seen as a longer-term investment option. Moreover, 39% of big anchor corporations and 44% of mid-sized businesses intend to offer incentives to their suppliers to encourage them to run their businesses and produce more sustainably. As consumers and investors are growing more conscious, expectations from stakeholders in the commitment to sustainable business practices have pushed local companies from developing countries to align their operations with sustainable performance goals (Morioka et al., 2017). More than 85% of the 500 fastest-growing Vietnamese companies have promised or intend to adhere to environmental, social, and governance (ESG) criteria, which also encompass sustainable supply chain practices. Nonetheless, owing to a lack of cognition, managerial dedication to advancing ESG, and explicit regulations, over half of Vietnamese businesses, the majority of which are small and medium-sized businesses, have not yet made any commitments or intentions on ESG going forward (PwC, 2022). Therefore, promoting sustainable supply chain practices is critical and challenging, especially in a less advanced economy. Adopting anything new always faces numerous obstacles, not just from the context inhibitors but also from operating such new practices (Ashby et al., 2012).

In alignment with such a trend, most businesses would now consider opting for more sustainability practices from diverse angles, including the supply chain. The conceptualization of a sustainable supply chain (SSC) stirs up the interest and debate of scholars worldwide and becomes the dominant talk in both the academic and practical world. Sustainable development can be defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs (Burton, 1987). Previous studies on the impact of SSC found mixed results on the 3 dimensions of performance as listed in the Triple Bottom Line model: economic, environmental, and social. While there were research findings on the positive impact of SSC on environmental performance and social performance (Mani et al., 2020), the impact on economic performance is still subject to some disagreement (Shou et al., 2019; Saqib & Zhang, 2021).

From the above findings, it is essential to conduct more comprehensive research to explore in greater detail and systematically collect impact factors of SCP for a better understanding of the underlying issue. The SSC inhibitors (SSCI) were incorporated in an effort to further investigate and understand its potential impacts better in the area of supply chain management. The authors aim to contribute more empirical evidence and explore the contextual distinction of Vietnamese corporations to enrich the knowledge of supply chain management in general and SSC in particular.

2. Theoretical framework and Literature review

2.1. Theoretical framework

The triple bottom line (TBL) was developed by Elkington (1997) and refers to a sustainability-related construct that includes economic, social, and environmental lines. TBL was insisted to place an equal effect on the economic, social, and environmental lines, which provided a framework for measuring business performance (Arowoshegbe et al., 2016). Additionally, Roger & Hudson (2011) pointed out that TBL has also been referred to as a practical framework for sustainability. This paper aims to investigate the impact of SSC Practices, SSCI and SSC Performance, thus, it is critical to incorporate the philosophy of TBL in order to further the understanding of related matters involved. By using TBL as the theoretical framework, SSC Performance in this paper will be broken down to smaller dimensions that allows a greater understanding of the impact that independent variables impose on each dimension of performances. A brief introduction of each dimension in TBL is provided below for a common background understanding of this work.

Firstly, the economic dimension of TBL is referred to as the impact of the organization's business practices on the economic system. The foremost social responsibility of businesses is economic performance, prioritizing it over environmental and social considerations within the triple bottom line framework because, without economic success, no supply chain can exist in the long run (Janker & Mann, 2020).

Secondly, the environmental dimension of TBL refers to engaging in practices that do not compromise the environmental resources for future generations (Arowoshegbe et al., 2016). It pertains to the efficient use of energy resources, reducing greenhouse gas emissions, minimizing the ecological footprint, etc. (Goel, 2010).

Thirdly, the social dimension of TBL is defined as conducting beneficial and fair business practices for labor, human capital, and the community. Simply put, social performance focuses on the interaction between the community and the organization and addresses issues related to community involvement, employee relations, and fair wages (Goel, 2010).

2.2. Literature review and hypotheses

SC Performance (SCP)

SCP covers the actions taken by the extended supply chain to satisfy end-user demands, which require multiple metrics to gauge a supply chain's capacity to satisfy an organization's short-term and long-term goals (Deshpande, 2012). Concerning the adoption of sustainability in the supply chain, SCP can be metricized based on three pillars, namely environmental, economic, and social, respectively (Thong & Wong, 2018). Environmental performance refers to a formal process that measures, analyzes, reports, and communicates an organization's environmental performance with standards established by management (Perera et al., 2013). Four items are required in this process, including improvement in its compliance to environmental standards, reduction in consumption for hazardous/harmful/toxic materials, improvement in efficient energy/resource use, improvement in company's environmental situation (Lee & Kashmanian, 2013).

Economic performance refers to the financial results and accomplishments of a company in terms of reduction of waste and its disposal costs (Hasanov et al., 2013), improvement of resource management efficiency (Kalaitzi et al., 2019), improvement of Return on Equity and of Return on Assets (Rahiminezhad & Mokhatab, 2022). The financial results and achievements explore the capacity of a company to cover all the costs associated with its economic activities (Duong, 2022).

Social performance is a collection of descriptive classifications of business activity that emphasize the effects and results for stakeholders, society, and the company itself. These classifications are improvement in product/service image in the eyes of its customers (Zailani et al., 2012), improvement in relations with community stakeholders, e.g., non-governmental organizations (NGO) and community activists (Busse et al., 2017), improvement towards a healthier work environment (Shekarian et al., 2022), improvement in training and human resource development (Haq et al., 2021).

Sustainable Supply Chain Practices (SSCP)

SSCP frequently involves supplier capability in earlier stages of the production design process to provide more cost-effective design choices and alternative conceptual solutions, choose the best technologies that aid in design assessment to help firms reduce waste, improve supplier relationships, and enhance transparency in the supply chain (Linton et al., 2007). Based on previous studies, Lam (2018) stated that SSCP includes conscientious actions or approaches that businesses take to address environmental issues along their supply chains, such as pollution, recycling, waste reduction, greenhouse gas emissions, and energy consumption, as well as social issues like human rights, working conditions, child labor, discrimination, and health and safety, which are indispensable in the adoption of SSCP. SSCP tools, solutions, approaches, methods, and strategies impacted SCP on three pillars of sustainability equally (economic, social, and environmental) (Shekarian et al., 2022).

From a decade ago, research into the impact of SSCP on the three pillars of SCP (economic, social, and environmental) was in its infancy. Until recently there was a few studies that applied the triple bottom line (TBL) framework to investigate this hypothesis between SSCP and SCP (Saqib & Zhang, 2021; Shou et al., 2019).

Implementing Sustainable supply chain practices (SSCP) can significantly enhance a firm's environmental performance. Waste management, environmental management systems, quality management, and product design are key drivers of improved environmental outcomes. Furthermore, integrating SSCP in the pre-assembly and assembly phases can minimize waste and reduce harmful emissions, promoting a cleaner and more efficient production process. Despeisse et al. (2012) showed that SSC practices significantly increase environmental efficiency and reduce environmental footprint through the optimized use of materials and natural resources. Therefore, we assume that:

H1a: SSCP have a positive influence on supply chain environmental performance.

The implementation of Sustainable supply chain practices (SSCP) can significantly enhance a firm's economic performance. Liu et al. (2012) emphasize that economic sustainability is a reduction of process costs, an increase in market share, enhanced profitability, and returns on assets associated with the economic intentions of the performance. Companies with sustainable SCP often experience improved economic performance through higher income, profits, and tax revenue, while also ensuring the financial well-being of their employees. Furthermore, research by Chan et al. (2012) demonstrates a strong link between SSCP and a firm's earning capacity, market share, sales growth, and return on investment. Their research showed that integrated SSCP can effectively reduce costs, enhance market share, and drive higher profits. Therefore, we assume that:

H1b: SSCP have a positive influence on supply chain economic performance.

The implementation of Sustainable supply chain practices (SSCP) can significantly enhance a firm's social performance. Firms engaging in SSCP can improve employee motivation and customer satisfaction with enhanced social performance (Shou et al., 2019). Ageron et al. (2012) supported this view with empirical study and developed that customer satisfaction, suppliers' innovation capacity, quality, trust, supply risk management, and fill rate are major benefits of the implementation of SSCP. In addition, by implementing SSCP, customers can obtain more eco-friendly and harmless materials (Gimenez et al., 2012). Reduction in harmful or toxic materials will improve occupational health and safety, enhancing social performance. Thus, there is a verified positive relationship between social sustainability measures and supply chain performance in manufacturing industries (Mani et al., 2020)

H1c: SSCP have a positive influence on supply chain social performance.

SSC inhibitors (SSCI)

Sustainability challenges consist of factors that hinder the achievement of the sustainability SCP through SSCP, known as sustainable supply chain inhibitors (SSCI). SSCI is defined as aspects of a supply chain that increase complexity or factors that reduce the chain's capacity to overcome challenges effectively. In this study, a set of SSCI are identified, namely cost implications, resistance to technology advancement adoption, unawareness of customers, missing communication, poor quality of human resources, lack of government support, lack of top management commitment and market uncertainty (Luthra et al., 2011).

Cost implication is one of the primary concerns for firms during the implementation of sustainable practices (Govindan et al., 2014). These costs are even more significant for SMEs, which typically have fewer resources and are thus more vulnerable. Firms must balance cost considerations with environmental goals because a strong environmental commitment often results in added costs, placing the firm at an economic disadvantage compared to less environmentally responsible firms. Resistance to technology advancement adoption is another barrier. Min and Galle (2001) argue that it might correlate positively with firm size because larger firms benefit from economies of scale that enhance the feasibility of innovative adoption. Larger firms accrue greater benefits from implementing innovative methods (Min & Galle, 2001). Tilley (1999) argued that small firms consequently perceived investment in environmental programs as a heavy economic burden, not a competitive advantage.

Unawareness of customers is another inhibitor. Sen & Bhattacharya (2001) found that a firm's sustainability efforts are influenced by the belief that stakeholders favor firms with good sustainability performance. However, consumers often lack full awareness of a firm's SSCM activities when purchasing. Missing communication creates more gaps in executing SSCM (Al Zaabi et al., 2013), as companies are often unwilling to exchange information on green supply for fear of exposing weaknesses or giving competitors an advantage. Meanwhile, Linton et al. (2007) stated that missing communication can lead to misunderstandings, lack of coordination, and inefficient practices, which hinder the comprehensive and seamless implementation of SSCP.

Poor quality of human resources is a major issue in SMEs, especially in emerging countries due to a lack of access to vocational training, meaning that the workforce may not be fully qualified for specific tasks. Meanwhile, the information systems related to SSCM are highly specialized, necessitating appropriate training and qualifications for effective operation (Zaid et al., 2018). In such cases, Bayraktar et al. (2009) suggested that SMEs should seek government assistance. A lack of government support limits the ability to adopt SSCP in emerging economies, especially for SMEs with limited skills and resources (Bayraktar et al., 2009). In emerging markets, the government plays both direct and indirect roles in adopting, promoting, and implementing sustainability and green practices (Luthra et al., 2011). Governments possess valuable resources that firms cannot access without governmental support.

Top management commitment plays a vital role in a company's social responsibility efforts. Without the top management’s commitment, building the proper strategic orientation and developing sustainable operations would be unrealistic (Kitsis & Chen, 2021).

Market uncertainty refers to the difficulty in predicting customer demand in the future (Taylor & Fearne, 2009). Economic instability, fluctuating demand, and competitive pressures can discourage companies from investing in sustainable supply chains (Seuring & Müller, 2008) because the market uncertainty introduces risk to supply chain members and adversely affects total performance. SSCI results in a negative impact on SSCP (Chirra et al., 2021), especially during the initial phase of sustainability practices (Al Zaabi et al., 2013). This negative and direct impact relationship is proven by many previous research articles in many different fields, including the fastener manufacturing industry (Al Zaabi et al., 2013), the mining industry (Muduli et al., 2013), the automobile industry (Gopal & Thakkar, 2016), rubber products manufacturing industry (Narayanan et al., 2019), etc. So, the following hypothesis is proposed for testing:

H2. There is a negative direct relationship between SSCI and SSCP.

To the best of the authors' knowledge, based on research over the past 15 years, most studies indicate a direct and negative relationship between SSCI and three aspects of SCP. Some studies on individual pillars show a direct and negative relationship between SSCI and SOSCP (Eriksson & Svensson, 2015), between SSCI and ENSCP (Muduli et al., 2013). No studies have been conducted on the relationship between SSCI and ECSCP. Several studies that encompass all three pillars in the SCP variable indicate different relationships, including direct and negative relationships (Gopal & Thakkar, 2016), indirect relationships (Mastos & Gotzamani, 2022), moderating influence on SSCP and SCP relationship (Sabir & Irfan, 2014) or no impact (Gokarn & Kuthambalayan, 2017). As previous studies on the relationship between SSCI and the three pillars of SCP are still under debate, it is necessary to re-examine this impact in the Vietnamese context to provide the much-needed empirical evidence for this relatively new research field. Thus, we proposed the following hypotheses:

H3a: There is a negative relationship between SSCI and supply chain environmental performance.

H3b: There is a negative relationship between SSCI and supply chain economic performance.

H3c: There is a negative relationship between SSCI and supply chain social performance.

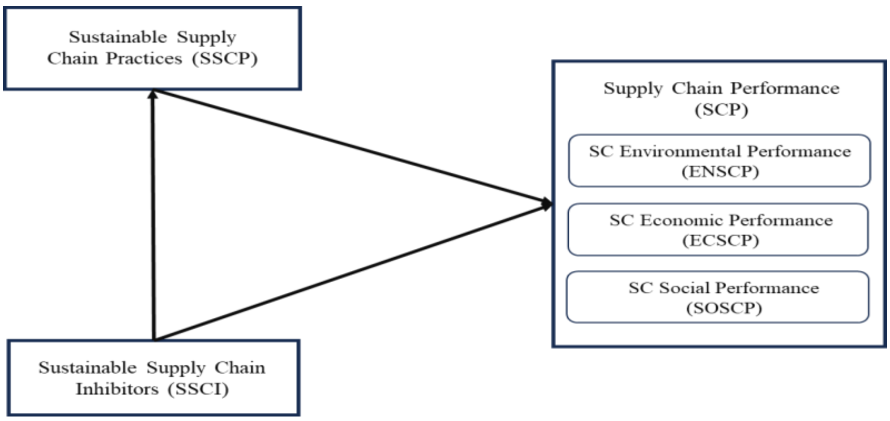

Figure 1: Research Model

Source: Compiled by the authors

3. Methods

3.1. Data collection and sample characteristics

Using a convenient method, the research sample was taken from the Research Institute for Innovation and Development's list of Vietnamese social enterprises. Our online survey invitations were sent through the companies' registered email addresses, and the hard copies were dropped at various company headquarters or professional gathering events such as seminars or conferences with topics related to sustainability or supply chain. There were 713 original invitations sent to 713 businesses, resulting in 261 (36,61%) agreeing to participate in the survey. In addition, each participating firm was asked to pick the participants from SCM-related and sustainability-related positions. This may include but is not limited to purchasing, warehousing, and procurement for SCM and different sustainability task forces or committee members who have knowledge or daily interaction with the underlying issues being invested in this paper. In total, 261 questionnaires (258 replies qualified for data analysis) were sent out, 67 hard copies and 194 soft copies.

Table 1: Sample Characteristics

Sample characteristics	Quantity	Ratio (%)
Industry	**258**	**100**
Tourism	8	3.1
Food	42	16.3
Educational	51	19.8
Information Technology	12	4.7
Agriculture	82	31.8
Garment & Textiles	14	5.4
Fashion	17	6.6
Others	32	12.4
Number of Employee	**258**	**100**
Less than 100	110	42.6
From 100 to 1000	119	46.1
From 1000 to 5000	26	10.1
Above 5000	3	1.2
Area	**258**	**100**
Northern	205	79.5
Central	20	7.8
Southern	33	12.8

Source: Compiled by the authors

3.2. Scales' measurement

The survey questionnaire consists of four sections with twenty-seven questions for 6 variables on a 5-point Likert scale. As our respondents are Vietnamese, the original questionnaire was translated from English to Vietnamese using a backward-translation method to ensure accuracy. The translation underwent a two-phase process. A qualified notarization office is hired to translate the original questionnaire from English to Vietnamese. This Vietnamese version will be given to an academic scholar with research experience to translate back to English independently to ensure nothing is lost in translation and the main idea of the questionnaire is well preserved. A pilot survey of 30 individuals was also conducted to gather feedback on the wording and denotation of the final questionnaire. Some alterations were made after the pilot survey to ensure the user-friendliness and clarity of the final questionnaire.

The scales used in the questionnaire were inherited from Gopal & Thakkar (2016) and Thong & Wong (2018) and adjusted to suit the Vietnamese context. The chosen scales were selected based on the following criteria: (i) The studies must be published in reputable academic, peer-reviewed journals; and (ii) The selected scales' papers have significant citations over time, indicating continuance support of subsequent scholars of the published works.

3.3. Data analysis

The survey was conducted both online and offline. The data from the hard copies is recorded and cleaned using Excel and then merged with the online data. Data analysis was processed using SPSS and AMOS in compliance with the following steps. First, to test the reliability of the measurement scales, the research team used Cronbach's Alpha (CA) and Corrected Item - Total Correlation (CI-TC), followed by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to examine the discriminant and convergent validity of the variables. Finally, a structural equation model (SEM) is employed to investigate the proposed hypotheses.

4. Results

4.1. Scale reliability and Exploratory Factor Analysis (EFA)

The scale's reliability results are presented in Table 3. The findings indicate that most of the measurement scales meet the requirement of CA>0.7 and CI-TC of > 0.3 (Hair et al., 2010). The deleted item with CI-TC <0.3 is SOSCP2.

EFA was run to test the construct validity between the model's variables. The results of EFA show that 0.5<KMO=0.858<1; Bartlett's sig. =0.000<0.05; Total Variance Explained is 69.203%>50% with an eigenvalue>1, and Factor loading of all items are higher than 0.7, which indicates that they have a good statistical explanation (Hair et al., 2010). However, ENSCP4 was removed as it did not meet the convergence and discriminant validity criteria.

4.2. Confirmatory Factor Analysis (CFA)

The CFA results indicate that the model fit satisfied all requirements, reliability was confirmed again by CR, p-value (<0.05), and standardized regression weight satisfies the minimum threshold of 0.5. Next, convergent and discriminant validity are tested using the Fornell and Larcker test. Results from the test showed that Composite Reliability (CR) ≥ 0.7 and Average Variance Extracted (AVE) ≥ 0.5 indicate that convergent validity is satisfactory. In addition, Maximum Shared Variance (MSV) < Average Variance Extracted (AVE) and Square Root of AVE (SQRTAVE) > Inter-Construct Correlations in Fornell and Larcker's table indicate that discriminant validity is satisfactory.

4.3. Hypothesis testing

SEM analysis was conducted to test the proposed hypotheses. Results showed that SSCP has positive impact on ENSCP, ECSCP, or SOSCP (p-value <0.05), with the strongest impact on ENSCP (β = 0.420), followed up by SOSCP (β = 403) and ECSCP (β = 0.286). Therefore, H1a, H1b, and H1c are supported. Next, there is no statistical evidence shows that SSCI has negative direct impact on SSCP and ECSCP, SOSCP, ENSCP (p-value>0.05). Thus, H2, H3a, H3b, and H3c is rejected. This model is shown to explain 27.8% of ENSCP, 19.6% of SOSCP and 8% of ECSCP.

5. Discussion

5.1. Discussion & implications

With Sig.<0.05 and standardized β= 0.42, 0.286, 0.403 for ENSCP, ECSCP and SOSCP respectively, the direct relationship results show that H1a, H1b, H1c are all accepted. In other words, only SSCP carries the impact on three dimensions of SSCP. Of all the statistically valid relationships, ENSCP bears the strongest impact from SSC Practices, then SOSCP, then ECSCP. SSCI, on the other hand, does not impact any other variables in this research.

This result is in line with previous studies where direct positive relationships between SSC Practices and SC Performance's dimensions were found (Zailani et al., 2012; Govindan et al., 2014). Therefore, the result of this study does not surprise the authors. Although this paper did not dive into different dimensions of SSC Practices, a more recent study of Asante-Darko (2022) suggested that practices such as employee incentive policies, employee turnover management, absenteeism management, ethnic and cultural diversity management, health and safety policies, ISO certification requirements, etc. would benefit from adopting SSCM initiatives. This is an extension that future papers in this same field can further explore to deepen the understanding and provide better insights into the impacts of different dimensions of SSC Practices and dimensions of SSC Performance. Future papers can also dig deeper into the unique challenges of Vietnamese supply chains to propose more meaningful recommendations for practitioners to build up the best SSC Practices for the Vietnamese market.

On the contrary, research results show that H3a, H3b, H3c and H2 are all rejected because sig<0.05. In other words, SSCI in this paper does not carry any impact to SSC Practices and SSC Performances' dimensions. These findings contradict many past studies where previous scholars had been able to prove statistically meaningful impact of SSCI on different dimensions of SSC Performance (Muduli et al., 2013; Gopal & Thakkar, 2016) or SSCI on SSC Practices (Al Zaabi et al., 2013; Gopal & Thakkar, 2016; Narayanan et al., 2019; Chirra et al., 2021). Previous studies stressed on the importance of the inhibitors and distinction between the impact of inhibitors and barriers in sustainable issues (Gopal & Thakkar, 2016). In the Vietnamese context, the implementation level of sustainable practices such as SSC Practices depends on many factors. The awareness of sustainability of the manager plays a crucial role. When the manager understands the benefit of sustainability, they can create more effective campaigns to implement the practices (Do et al., 2020). Like many other Asian countries, the Vietnamese have a boss-follower culture. The support of top management within a company is crucial in surpassing any inhibitors' impact when implementing anything, not just sustainable-related issues. This has been proved in new product development, Total quality management system implementation (Jun et al., 2006), and the like. This might explain why SSCI has not yet impacted SSC Practices in this research context. Future papers can explore the impact of top management support in this matter to obtain a more profound understanding of the big picture.

Moreover, the findings of SSCI impacts on SCP dimension are still under debate. Despite confirmations of significant impact from the above-mentioned studies, there are other studies that suggested no impact (Gokarn & Kuthambalaya, 2017) or an indirect impact between SSCI and SCP through the mediate variable SSCM practices (Mastos & Gotzamani, 2022). This phenomenon can be explained by the different levels of contextual factors in different research. For example, this paper' findings reflect a majority of Vietnamese businesses' positions when it comes to SSC knowledge and facilitating conditions. The Vietnamese business community is dominated by small and medium-sized companies that lack of full understanding of the potential economic benefits of SSC and do not have a clear strategy for implementation. In addition, Vietnamese support systems are still in development stages thus contributing to difficulties for firms in accessing the necessary financial resources, information, and technical support to implement SSC effectively. These prevent the Vietnamese companies from getting enough information to analyze their situations, identify the inhibitors, and understand their effect, which leads to no impact of SSCI in this research context. These might change in the future.

Sustainable activity trends are gaining popularity, particularly those on developing sustainable supply chains in Vietnam. Building a sustainable supply chain as a competitive advantage to affect customers, the government, and other key subjects appears to be understood by largest and small and medium-sized businesses. However, only major Vietnamese firms apply the concept of constructing sustainable supply chains. In order to be able to support efforts on building sustainable supply chains in Vietnam in general and companies of all sizes, in particular, more effectively, businesses must first concentrate on training personnel, from management level personnel to employees, raise awareness and a better understanding of the importance, role, and value that building sustainable supply chains brings as well as the dimensions of sustainable supply chain practices. Simultaneously, companies can use internal incentive programs or awards to motivate their staff to generate ideas that advance the company's supply chain and conduct acts that benefit the change of the company's supply chain practices towards a more sustainable-friendly direction. Simultaneously, to cater to the globalization trend that is gaining momentum both globally and in Vietnam, Vietnamese enterprises should design their quality standard systems and quality management standards following international standards targeted at sustainable development, such as ISO 14001:2015 standards on environmental management systems and ISO 26000 standards on the responsibility society between businesses and employees. This will help Vietnamese businesses approach environmental and social performance improvement more systematically and well-structured. Finally, another factor influencing the implementation of sustainable practices is knowledge management strategies such as codification and personalization, processes, platforms, and partnerships. If knowledge can be collected, stored, transferred and shared along the supply chain effectively, it surely will speed up the implementation process of more sustainable-friendly practices of related companies. Vietnamese companies can focus their limited resources in investing on knowledge management to gain a better result throughout their total sustainable-friendly transformation processes.

5.2. Limitations and future research

Due to limited time and resources, there are some limitations that future studies can further improve to achieve more comprehensive research. *Firstly*, the sample size is modest, with a convenient sampling method, and 258 replies will have a certain impact on the final findings if generalized to a bigger population. Future research should put more effort into collecting more samples using more objective sampling methods to improve the dependability of the results. *Secondly*, the current study variables can only explain 8% of the volatility in supply chain economic performance, thus, other meaningful antecedents were not included in this paper. Future studies should be more diverse and find more significant impact factors to fill in this gap. As mentioned above, the authors also call for further exploration into the impact of top management support in SSC Practices and the division of SSC Practices into smaller dimensions to better understand the underlying issues.

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Appendix 1: Scales inheritance

No	Variable name	No of items	Inherited from
1	SSC Practices (SSCP)	5	Gopal & Thakkar (2016)
2	SSC Inhibitors (SSCI)	5	
3	SC Environmental Performance (ENSCP)	4	Thong & Wong (2018)
4	SC Economic Performance (ECSCP)	4	
5	SC Social Performance (SOSCP)	5	

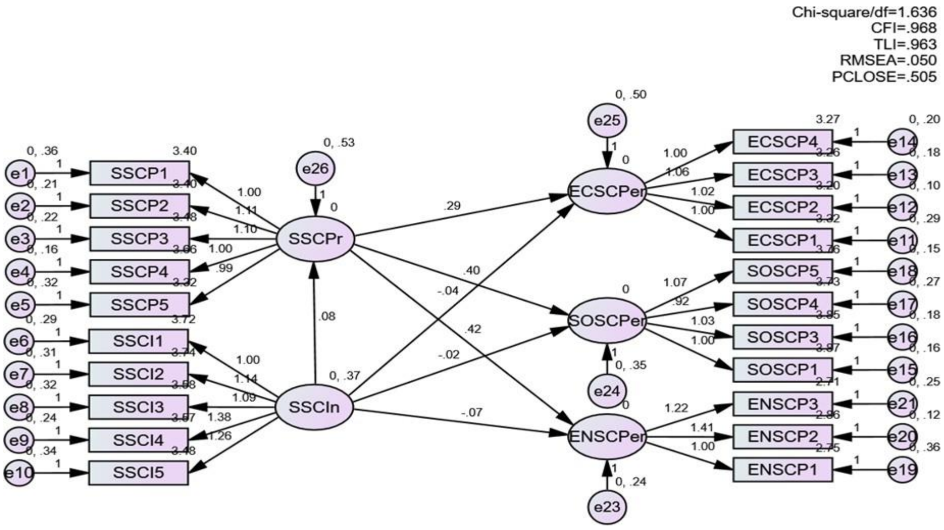
Appendix 2. Reliability Test, SEM model summary and Hypothesis testing.

Reliability Test

Variables	Item	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Factor Loading
Cronbach's Alpha = 0.849				
	ENSCP1	0.639	0.862	0.631

ENSCP	ENSCP2	0.801	0.707	0.970
	ENSCP3	0.721	0.787	0.790
Cronbach's Alpha = 0.922				
	ECSCP1	0.767	0.917	0.789
	ECSCP2	0.870	0.883	0.925
ECSCP	ECSCP3	0.831	0.894	0.889
	ECSCP4	0.816	0.899	0.863
Cronbach's Alpha = 0.902				
	SOSCP1	0.794	0.869	0.854
	SOSCP3	0.798	0.867	0.885
SOSCP	SOSCP4	0.712	0.898	0.704
	SOSCP5	0.820	0.859	0.878
Cronbach's Alpha = 0.919				
	SSCP1	0.744	0.910	0.784
	SSCP2	0.828	0.893	0.884
SSCP	SSCP3	0.816	0.895	0.871
	SSCP4	0.825	0.895	0.872
	SSCP5	0.747	0.909	0.744
Cronbach's Alpha = 0.890				
	SSCI1	0.702	0.873	0.749
	SSCI2	0.735	0.865	0.799
	SSCI3	0.716	0.870	0.764
SSCI	SSCI4	0.793	0.852	0.853
	SSCI5	0.722	0.869	0.773

SEM model summary



Hypothesis testing

Variables	Status	P-value	Standardized β
CMIN/DF		1.636	
CFI		0.968	
RMSEA		0.050	
PCLOSE		0.505	
ENSCP ← SSCP	**Accepted**	0.000	0.420
ECSCP ← SSCP	**Accepted**	0.000	0.286
SOSCP ← SSCP	**Accepted**	0.000	0.403
SSCP ← SSCI	*Rejected*	0.307	0.084
ENSCP ← SSCI	*Rejected*	0.254	-0.068
ECSCP ← SSCI	*Rejected*	0.603	-0.042
SOSCP ← SSCI	*Rejected*	0.815	-0.016

Impact of Green Logistics on Intra-Asean Trade

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Abstract

Established in 1993 to boost intraregional trade and global competitiveness, the ASEAN Free Trade Area (AFTA) has removed many trade barriers. However, intra-ASEAN trade remains limited due to non-tariff measures, logistical challenges, and inefficient customs procedures. Improving trade infrastructure and modernizing customs processes through green logistics could boost trade within ASEAN while mitigating environmental impacts. Despite its significance, there is a lack of comprehensive studies on its impact on intra-ASEAN trade, especially studies to quantify this effect. This research addresses this gap by employing Principal Component Analysis to develop the Green Logistics Performance Index (GLPI) from six Logistics Performance Index variables and four greenhouse gas emission variables. Utilizing an expanded gravity model, GLPI and its subindexes assess the effects of green logistics on trade among nine ASEAN countries from 2010 to 2021. Results reveal that Improvements in GLPI, especially in cargo transportation timeliness, significantly enhance trade values, with a greater impact on exports. Additionally, economic and geographic factors - GDP, population size, trade openness, and shared borders or languages - positively influence trade between partners, while geographical distance poses a significant barrier. These findings are robust across different estimation methods (OLS, FGLS, and PCSE). Therefore, this paper offers valuable insights for aligning green logistics with economic and trade policies, emphasizing the need for a long-term strategy focused on infrastructure development and investment in centralized logistics centers to support sustainable trade. Regional cooperation is also crucial for sharing best practices and harmonizing environmental regulations to enhance global competitiveness.

Keywords: *ASEAN, gravity model, green logistics, PCA, trade*

1. Introduction

Logistics, often referring to the movement of goods from a source of raw materials to final consumption, has become a key driver of international trade competitiveness and national economic growth (Bensassi et al., 2015). However, the sector is also a significant contributor to environmental degradation, with 5.5% of greenhouse gas emissions attributed to logistics (McKinnon, 2010). Distribution processes contribute to global warming, noise pollution, reduced air quality, and accident risks. As environmental concerns have become more prevalent with unpredictable detrimental impacts, companies face increasing pressure to reduce the environmental impacts of their logistics operations.

Recent research focuses on achieving sustainable logistics practices, leading to the rise of "green logistics". "Green logistics" is the core industry that studies the environmental impact of all operations related to the transportation, storage, and handling of physical goods as they move through supply chains in both forward and backward orientations. This sector evaluates the kind and extent of these impacts and looks at the approaches that might be taken to lessen them (McKinnon et al., 2015). When it comes to intra-ASEAN trade, several factors are taken into consideration when regional trade remains limited. Non-tariff measures, such as sanitary regulations, pre-shipment inspections, and rules of origin, add significant trade costs, hindering economic growth (Anderson & van Wincoop, 2003; Cadot et al., 2018; Ing et al., 2016; Plummer et al., 2016). Additionally, logistical challenges, customs procedures, and other trade facilitation issues further restrict trade (Okabe & Urata, 2014). Nevertheless, improving both hard and soft trade infrastructure could address these barriers, with the benefits of trade facilitation potentially outweighing those of tariff reductions (Cadot et al., 2017; Shepherd & Wilson, 2009). Given that

ASEAN's strategic location makes it a vital hub in the complex web of regional and international trade, green logistics would help to facilitate trade within the region.

There is evidence suggesting that logistics influences trade in multiple ways (Le et al., 2022). The logistics industry contributes an average of 5% of the GDP, with its importance increasing as global trade grows (Gani, 2017). Regional economic integration has increased the frequency and competitiveness of transregional trade across markets, making logistics a critical factor in a competitive trade environment (Tang & Wang, 2020). Studies by Wang et al. (2018) and Song and Lee (2022) using the gravity model show a positive relationship between logistics performance and trade. According to Riadh (2020), one immediate effect of improved logistics performance is a reduction in transportation costs, which in turn promotes trade expansion. **Green logistics,** distinct from traditional logistics, aims primarily at reducing the environmental impact of logistics operations while promoting balanced development across environmental, social, and economic dimensions. Unlike conventional logistics that focus on cost reduction, green logistics activities are driven by environmental concerns (Wang et al., 2018). They provide practical solutions to "green barriers" in international trade and contribute to sustainable trade development (Ren & Huang, 2015). As intra-regional trade volumes continue to grow, enhancing green logistics performance is expected to further optimize the regional trade environment.

In order to assess how regional trade agreements affected Vietnam's export and import activities, Tran (2024) conducted research using principal component analysis (PCA) and the gravity model. The findings indicate that exports and the effectiveness of green logistics are positively correlated. However, the PCA-based GLPI may not fully capture the complexities of green logistics performance, as the study overlooks factors like greenhouse gas emissions and fossil fuel consumption. Fan et al. (2022) use the gravity model and entropy method to construct GLPI, from 6 LPI traditional variables and specific emissions (CO_2, N2O, CH4, F-gases, fossil fuels). Their findings indicate that green logistics performance in RCEP countries significantly enhances China's export trade to these countries. Other studies, such as those by Wang et al. (2018) and Le et al. (2022), utilized the Environmental Logistics Performance Index and logistics CO2 intensity to evaluate the effects of green logistics on global trade and economic growth. Overall, these studies show that green logistics performance in exporting nations favorably influences the export volume, and in the long term, countries engaging in green logistics would increase trade volume within the regional trade area. Furthermore, Yingfei et al. (2021) used Partial Least Squares Structural Equation Modeling to evaluate the influence of green logistics performance and infrastructure on service trade and the environment. However, since the data was collected at a single point in time, a longitudinal study would provide a more accurate representation of these findings.

Despite the significance of green logistics, there remains a lack of research specifically focusing on its impact on intra-ASEAN trade. Ardine et al. (2023) examined the effect of logistics performance on export value within the ASEAN region by using the gravity model with bilateral trade data. The study found that logistics performance improvements by both the public and private sectors significantly increase export value. However, the use of PPML instead of a fixed-effects model means that impacts on exports are initially calculated by levels, not percentage changes, and the lack of cost and time data for documentary and border compliance from 2018 affects the study's reliability. Shepherd et al. (2009) and Sy et al. (2020) also used the gravity model and suggested that improved logistics could lead to trade expansion within ASEAN; nonetheless, these studies approach logistics performance and trade from a macro perspective, which may overlook specific details.

In conclusion, green logistics have significant effects on boosting regional trade but research about its impacts on intra-ASEAN trade is limited. Many studies focus on a macro level, and when it comes to methodology, both domestic and international scholars primarily use the LPI index to gauge logistics performance, often neglecting the historical context and the impact of fossil fuel consumption and low-carbon greenhouse gas emissions on logistics performance. Additionally, the lack of available data on ASEAN trade further diminishes the reliability of such studies. Therefore, this study aims to build a more comprehensive LPI and green factors index based on the extended gravity model to examine the influence of green logistics on intra-ASEAN trade. Thus, by putting out a Principal Component Analysis-based methodology for computing the GLPI, this study seeks to close this gap. Using an expanded gravity model, this index will be crucial in evaluating the effects of green logistics on intra-ASEAN trade in 9 ASEAN countries during the period from 2010 to 2021.

2. Methods

The research methodology integrates both qualitative and quantitative approaches. The qualitative phase involves a comprehensive literature review that systematically analyzes existing studies on green logistics performance and intra-ASEAN trade. In the quantitative phase, Principal Component Analysis (PCA) is employed to extract key information and reduce data complexity without losing the richness of the original dataset (Tran, 2024). PCA plays a crucial role in developing the Green Logistics Performance Index (GLPI), which is designed to efficiently represent green logistics performance. To accurately capture the impact of environmental parameters, these are inversely valued to reflect their detrimental effects on green logistics performance. The GLPI is computed using the two principal components identified through PCA, as shown in Table 1. Component 1 incorporates traditional logistics metrics into the Logistics Performance Index (LPI), while Component 2 focuses on vital environmental factors.

Table 1: GLPI component variables

Principal components	Component variables	Data source
Logistics factors	Custom, Infra, Ship, Quality, Tracing, Timeliness	World Bank
Green factors	CO2, F-GAS, CH4, N2O	Climate Watch

Source: Authors' compilation

This paper employs an empirical study on the impact of green logistics on intra-ASEAN trade with 9 ASEAN member countries using the gravity model. The gravity model was first applied into the study of international trade by Pöyhönen (1963) when he investigated the relationship between trade scale, GDP of each country, and the distance between two countries. Table 2 shows the major variables in this model. Below are equations for the applied gravity model:

$lnExport_{ijt} = B0 + B1*lnGLPI_{it} + B2*lnGLPI_{jt} + control + u_{ijt}$ (1)

$lnImport_{ijt} = B0 + B1*lnGLPI_{it} + B2*lnGLPI_{jt} + control + u_{ijt}$ (2)

$lnExport_{ijt} = B0 + B1*lnGLPIsub_{it} + B2*GLPIsub_{jt} + control + u_{ijt}$ (3)

$lnImport_{ijt} = B0 + B1*lnGLPIsub_{it} + B2*GLPIsub_{jt} + control + u_{ijt}$ (4)

Where Exijt - export value from country i to j in year t, and Imijt - import value from country i to j in year t; GLPIit and GLPIjt are green logistics performance of country i and country j in year t; GLPIsubit and GLPIjt represent 6 logistics variables and 4 green variables in table 1 of country i and country j respectively in year t. Others are control variables, expressed in logarithmic form, except for dummy variables. (a) GDPit and GDPjt are gross domestic product of country i and country j in year t; (b) Popit and Popjt are population of country i and country j in year t; (c) Openit and Openjt represent trade openness of country i and country j in year t; Disij is the distance from country i to j; Borderij and Langij are dummy variables (1 = have common borders/ language, 0 = otherwise); uijt is the standard error.

Table 2: Description of Variables

No	Variables	Description	Data Sources	Expected Signs
Dependent variable				
1	Ex	Export value	World Bank	
2	Im	Import value	World Bank	
Independent variable				

No	Variables	Description	Data Sources	Expected Signs
1	GLPI	Green logistics performance index	Authors' compilation	+
2	GDP	Gross Domestic Product	World Bank	+
3	Pop	Population	World Bank	+
4	Open	Trade openness	World Bank	+
5	Dis	Geographic Distance	Distancefromto	-
6	Border	Common border	Authors	+
7	Lang	Common language	Authors	+

Source: Authors

Based on data availability, this paper includes panel data from 2010 to 2021 across 9 ASEAN member countries (except Brunei). For panel data, several methods can be used, including Pooled OLS regression, Fixed Effects Model (FEM), and Random Effects Model (REM). Variance Inflation Factor (VIF) was first used to examine the existence of multicollinearity. The F-test and Hausman test helped select the most suitable model, while the modified Wald test and Wooldridge test examined heteroskedasticity and autocorrelation. The model was further estimated using Feasible Generalized Least Squares (FGLS) and Panel Corrected Standard Errors (PCSE) to correct for both heteroskedasticity and serial correlation and enhance the accuracy of the estimates.

After investigating previous papers, the research team proposes research hypotheses as follows:

Green logistics focuses on reducing the environmental impact of logistics activities by optimizing transportation, minimizing energy consumption, and enhancing efficiency through sustainable practices. Studies by Ardine et al. (2023) highlight the positive impact of overall logistics performance on intra-ASEAN trade; whereas, Çelebi (2019) and Gani (2017) emphasize that high logistics performance, including green logistics, significantly enhances trade flows by reducing transportation costs and improving supply chain efficiency. Therefore, the study proposes the hypothesis ***H1: Green logistics performance positively influences intra-ASEAN trade.***

Gross Domestic Product is the most commonly used indicator of economic activity, which measures the production in an economy (Aitken, 2019). Research by Tran (2024) suggests that a larger economy with more resources available for both production and consumption is reflected in a greater GDP, which in turn leads to rising trade values. Therefore, the study proposes the hypothesis ***H2: Gross Domestic Product positively influences intra-ASEAN trade.***

Population measures the total number of people living in a country. According to Tran (2024), larger population sizes are correlated with higher trade volumes. This can lead to increased labor force size, a larger domestic market, and a wider foundation for innovation and specialization, all of which can result in higher trade and output levels. Thus, the study proposes ***H3: Population positively influences intra-ASEAN trade.***

Trade openness generally refers to trade liberalization policies such as reduced tariffs and non-tariff barriers, which might promote higher flow of goods and services between nations. Research by Tran (2024) suggests that more open economies have higher trade volumes. Therefore, the study proposes the hypothesis ***H4: Trade openness positively influences intra-ASEAN trade.***

Geographic distance is measured to capture the circle of distance (in kilometers) from capital cities of host and source countries. Shipping costs are the main reason that distance is included in the gravity model. A research by Ardine et al. (2023) suggests that the export value will decrease with increasing distance. This finding is consistent with Khayat's (2019) finding that geographic proximity reduces the expenses associated with transportation, delays, spoilage, and the information gathering on the partners' legal and administrative processes. Therefore, the study proposes the hypothesis ***H5: Geographical Distance negatively influences intra-ASEAN trade.***

Common border and Common language: According to research by Anderson (2010), the fit of traditional gravity improved when supplemented with other proxies for trade frictions, such as the effect of borders, common language and the like. That is why borders and language are included in the augmented gravity model for this paper. Besides, another paper suggests that nations with similar languages would trade more (Head, 2003). Studies by Le et al. (2022) and Sy et al. (2020) also indicate that countries with shared borders can enhance trade efficiency. Therefore, the study proposes the hypotheses:

H6: Common border positively influences intra-ASEAN trade.

H7: Common language positively influences intra-ASEAN trade.

3. Results

3.1. Description of green logistics performance index by countries

Table 3: Green logistics performance of 9 ASEAN countries during 2010 - 2021

Year	Cambo dia	Indone s-ia	Laos	Malays -ia	Myanm -ar	Philipp i-nes	Singap-ore	Thai-land	Viet Nam
2010	0.9	1.136	1.02	2.359	0.125	1.843	4.028	2.051	1.516
2011	0.831	1.286	1.285	2.422	0.171	1.756	4.022	1.957	1.555
2012	1.009	1.437	1.224	2.467	0.199	1.665	4.023	1.859	1.586
2013	1.152	1.555	1.127	2.543	0.107	1.644	3.903	2.072	1.704
2014	1.306	1.67	1.046	2.608	0.01	1.625	3.784	2.284	1.826
2015	1.349	1.588	0.731	2.48	0.179	1.504	3.872	2.142	1.678
2016	1.428	1.51	0.386	2.333	0.39	1.379	3.966	1.991	1.532
2017	1.238	1.64	0.982	2.171	0.251	1.408	3.83	2.117	1.777
2018	1.062	1.771	1.514	2.006	0.138	1.446	3.7	2.249	2.02
2019	1.003	1.702	1.348	2.172	0.145	1.591	3.812	2.29	2.009
2020	0.936	1.637	1.157	2.335	0.147	1.738	3.926	2.328	1.999
2021	0.87	1.57	1.124	2.489	0.163	1.885	4.036	2.371	1.989
Mean	1.089	1.54	1.077	2.364	0.167	1.622	3.907	2.141	1.764
Rank	7	6	8	2	9	5	1	3	4

Source: Authors

Between 2010 and 2021, ASEAN countries exhibited varied green logistics performance, as detailed in Figures 1 and 2. Singapore stood out with the highest GLPI score of 3.908, reflecting superior green logistics efficiency. Malaysia and Thailand also performed well, with scores of 2.366 and 2.143, respectively. Indonesia, the Philippines, and Vietnam demonstrated solid performance with GLPI scores between 1.766 and 1.542. Indonesia improved steadily from 1.136 in 2010 to 1.570 in 2021, peaking in 2018. The Philippines increased from 1.843 to 1.885, while Vietnam rose from 1.516 to 1.989, peaking in 2018. Cambodia and Laos had moderate performance with scores of 1.090 and 1.079. Cambodia peaked at 1.428 in 2016 but declined to 0.870 by 2021. Laos fluctuated but recovered to 1.124 in 2021. Myanmar lagged behind with the lowest GLPI score of 0.169, showing minimal growth. This summary highlights the substantial disparities in green logistics performance across the ASEAN region, with varying levels of efficiency and stability.

In terms of logistics efficiency and environmental impact (fig. 1 and 2), Singapore excelled across all subindices—customs, infrastructure, shipping, quality, tracking, and timeliness—while maintaining the lowest CO2 (44.68) and CH4 (3.858) emissions. Malaysia and Thailand also showed strong logistics performance but faced significant environmental challenges, with Malaysia having high CO2 emissions (220.728) and Thailand substantial CO2 (264.048) and F-gas emissions (40.058). Vietnam performed well in logistics, especially in shipping and timeliness, but had moderate environmental impact, with CO2 (218.636) and CH4 (88.216) emissions. The Philippines and Indonesia showed good logistics performance, with the Philippines excelling in timeliness and Indonesia in shipping, though Indonesia had very high CO2 emissions (1161.706). Cambodia and Laos had moderate logistics performance and lower environmental impact, with Cambodia's CO2 emissions at 52.688 and Laos's even lower. Myanmar had the lowest scores in both logistics and environmental impact, with poor logistics performance and CO2 emissions at 125.565. **Overall**, while Singapore leads with excellence in both logistics and environmental efficiency, other countries like Malaysia, Thailand, and Vietnam show strong logistics capabilities but varying environmental impacts. Countries such as Cambodia, Laos, and Myanmar face challenges that highlight the need for targeted improvements in both logistics efficiency and environmental sustainability.

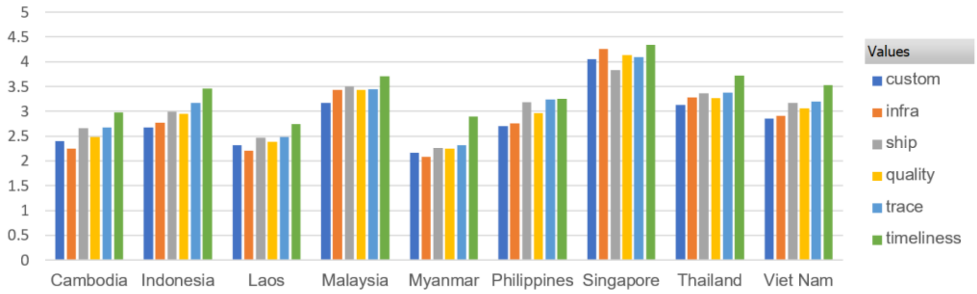

Figure 1: Mean logistics levels of 9 ASEAN countries

Source: Authors

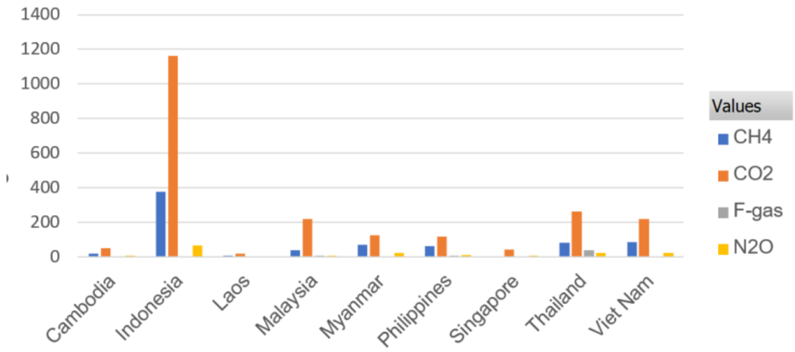

Figure 2: Mean greenhouse gas levels of 9 ASEAN countries (unit: MtCO2e)

Source: Authors

3.2. Regression analysis

LnGLPI of country i and j positively and statistically significantly affects both lnExport (exports) and lnImport (imports). This indicates that improved green logistics performance in the one country boosts its export and import, as supported by findings with Asia-Pacific Economic Cooperation (Le et al., 2022), Vietnam (Tran, 2024), and China (Fan et al., 2022). Enhanced green logistics can reduce transportation costs, improve efficiency, and meet international environmental standards, making its products more competitive and increasing its import needs due to greater economic activity. These improvements likely attract more foreign buyers and facilitate higher trade volumes. One noticeable pattern is that green logistics performance has a greater effect in the export model than import model due to bigger coefficients. This finding is consistent with results in models using GLPI sub-indexes below and supported by results of Tran (2024). These findings suggest that countries should focus on improving green logistics to enhance both their export and import activities.

Table 4: Estimation results on the impact of GLPI on intra-ASEAN trade

lnExport	(1a)		(1b)		(1c)	
	FGLS	PCSE	FGLS	PCSE	FGLS	PCSE
$lnGLPI_i$	0.260***	0.256***	0.314***	1.607***	0.914***	1.973**
	[7.50]	[4.57]	[5.50]	[10.33]	[5.46]	[2.06]
$lnGLPI_j$	0.208***	0.184***	0.216***	1.093***	0.418***	1.125
	[6.33]	[3.71]	[4.42]	[9.74]	[3.04]	[1.61]
lnImport	(2a)		(2b)		(2c)	
$lnGLPI_i$	0.0808***	0.111**	0.263***	0.438**	0.518***	1.105
	[2.58]	[2.06]	[4.94]	[2.45]	[3.74]	[1.63]
$lnGLPI_j$	0.287***	0.373***	0.219***	0.438***	0.710***	1.711**
	[7.67]	[5.13]	[4.78]	[2.73]	[4.85]	[2.03]
* p<0.1, ** p<0.05, *** p<0.01 t statistics in brackets						

Source: Compiled by the authors

lnGDP is positive and statistically significant in both export and import models, showing that larger economies trade more with each other. Notably, lnGDP1 has a higher coefficient than lnGDP2 in the export model, while lnGDP2 surpasses lnGDP1 in the import model. This suggests that the size of the exporter's economy may more strongly influence trade volume. A larger GDP for exporting nations indicates a more robust economy, better infrastructure, technological advancements, and reduced export costs. It also suggests higher purchasing power, leading to increased imports. This relationship aligns with the gravity model (Anderson & Van Wincoop, 2003) and research by Ardine et al. (2023) and Fan et al. (2022). **LnPop** also positively affects trade, as a larger population offers a bigger workforce, increased domestic demand, and production capacity, leading to higher trade volumes. This view is supported by studies from Le et al. (2022) and Tran (2024). For ASEAN countries, representing about 8.52% of the world's population (Worldometer, 2024), the demographic advantage significantly influences economic strategies. **LnOpen** has positive coefficients, showing that greater trade openness leads to higher trade volumes, consistent with Tran (2024). Increased trade openness reduces barriers, expands market access, integrates economies into global supply chains, and fosters improved trade relationships and economic efficiency, thereby boosting both imports and exports.

LnDis has a statistically significant and negative effect on trade, as distance increases transportation costs and logistical challenges, reducing trade volumes. Both exporting and importing countries should seek to mitigate this impact by improving transportation infrastructure or negotiating trade agreements that ease logistical barriers. This aligns with trade theory, particularly the gravity model, as supported by Anderson and van Wincoop (2003), Eaton and Kortum (2002), and Ardine et al. (2023).

Lang positively and significantly influences trade. A common language facilitates communication and reduces transaction costs, enhancing trade. Countries sharing a language should capitalize on this by fostering language and cultural exchanges to strengthen trade relations. Evidence from Melitz (2008) and Le et al. (2022) supports the role of language in trade facilitation. **Border** also has a positive, though less statistically significant, effect on trade. Shared borders reduce trade barriers by cutting transportation costs and simplifying logistics, enabling more frequent and efficient trade. This finding is consistent with Le et al. (2022) and Sy et al. (2020).

Table 5: FGLS Estimation results on the impact of GLPI sub-indexes on intra-ASEAN trade

	ln Custom	**ln Infra**	**ln Ship**	**lnQuality**	**ln Trace**	**ln Time**	**ln CH4**	**ln CO2**	**ln Fgas**	**ln N2O**
Dependent variable: lnExport (3)										
i	3.235*** [12.81]	2.944*** [13.36]	3.13*** [11.91]	2.812*** [10.14]	2.413*** [9.51]	5.252*** [17.94]	-0.291*** [-5.85]	-0.388*** [-9.24]	0.108*** [8.42]	-0.434*** [-8.25]
j	2.151*** [10.91]	1.93*** [11.13]	2.915*** [12.57]	2.088*** [9.23]	2.61*** [11.98]	3.794*** [14.81]	-0.183*** [-4.10]	-0.391*** [-11.37]	0.113*** [8.02]	-0.313*** [-6.48]
Dependent variable: lnImport (4)										
i	0.525* [2.32]	0.491* [2.42]	0.754** [2.81]	0.650** [2.73]	0.323 [1.43]	0.943*** [3.43]	-0.120* [-2.43]	-0.0484 [-1.31]	0.08** [3.26]	-0.182* [-2.50]
j	0.966*** [4.03]	1.201*** [5.75]	1.440*** [4.85]	1.042*** [4.28]	0.933*** [3.84]	1.863*** [6.60]	-0.277*** [-6.02]	-0.108** [-2.64]	0.092*** [3.30]	-0.386*** [-5.22]
* p<0.1, ** p<0.05, *** p<0.01 t statistics in brackets										

Source: Authors compiled

As observed in table 5, **Logistics performance variables** including customs performance (Customs), infrastructure quality (Infra), ease of arranging shipments (Ship), consignments tracking and tracing (Trace), logistics services quality (Quality), and timeliness of cargo transportation (Time) positively affect trade. These findings are supported by Marti and Puertas (2017), Çelebi (2019), and Sy et al. (2020). Notably, Timeliness emerges as having the most significant impact on both exports and imports. **Environmental variables** such as CH4, CO2, and N2O negatively affect trade due to the stringent regulations imposed to control their emissions. These regulations often lead to higher compliance costs and potential trade barriers, as countries with high levels of these emissions may face increased tariffs or reduced market access. In contrast, fluorinated gasses (F-gas), despite also being potent greenhouse gasses, tend to positively influence trade. This is likely because F-gas are crucial for various industrial processes such as refrigeration and air conditioning, making them essential for certain sectors.

Additionally, F-gas might face relatively less stringent regulatory pressure compared to CO2, CH4, and N2O, which can facilitate trade in industries dependent on these gasses.

The coefficients for logistics performance variables are **larger** than those for environmental variables, suggesting that improving logistics performance has a greater influence on increasing trade flows compared to reducing greenhouse gas emissions. The study by Le et al. (2022) supports this result. Given the greater impact of logistics performance on trade, ASEAN nations should prioritize enhancing logistics infrastructure and processes. However, this may be just a short-term strategy. While focusing on logistics improvements, they need to integrate environmental considerations into logistics strategies to ensure sustainable trade practices.

Also, both Logistics and environmental variables have larger coefficients in the export model compared to the import model; and in the import models, these variables of countries j have higher coefficients, suggesting that the logistics and environment performance of exporting countries has a greater impact on trade flows. This finding is consistent with models using the GLPI and supported by Tran (2024), who attributed this to some factors. Firstly, global markets might prioritize sustainability more, which could have a bigger impact on exports than on imports. Secondly, industries in ASEAN that focus on exports may be more advanced in adopting green logistics practices compared to those centered on domestic consumption or imports.

Finally, similar to regression results using GLPI in table 4, variables of GDP, trade, and border variables all exhibit positive and significant effects on trade flows in all models using GLPI sub-indexes while distance presents barriers; however, the language variable is less consistently significant.

4. Discussion and Conclusion

In conclusion, the gravity model analysis for ASEAN countries underscores several key insights into trade dynamics. The findings indicate that enhancing green logistics can significantly boost intra-ASEAN trade, with a particularly more notable effect on exports. On component variables of GLPI, their order of influence degree is the timeliness of cargo transportation, ease of arranging shipments, infrastructure quality, logistics services quality, customs performance, consignments tracking and tracing and the intensity of CH4 and CO2 emission. The continued emphasis on economic size, population, trade openess and geographical proximity highlights the multifaceted nature of trade dynamics within the ASEAN region.

The paper offers several policy recommendations to leverage these insights and foster stronger trade relationships within the ASEAN region and beyond. First, the government should develop a cohesive legal framework with clear regulations for logistics activities, including multimodal and cross-border transportation, and integrate international logistics commitments into domestic laws. The government must mandate qualifications and certifications for vehicle operators to ensure energy efficiency and sustainability, and enforce policies on green packaging and waste management in manufacturing and warehousing. Additionally, effective environmental regulations, including carbon taxation and subsidies, will drive progress in green logistics. The government should also ensure rigorous regional coordination by aligning national logistics policies with the ASEAN Green Logistics Framework to promote consistent, environmentally friendly practices across the region, boost global competitiveness, and improve citizens' quality of life. Also, the more significant influence of green logistics on exports compared to imports highlights the importance of customizing green logistics strategies for each area. Policymakers should examine how trade agreements and domestic regulations can encourage green logistics practices, enhancing export performance while also managing their subtler effects on imports. This tailored approach could help balance economic growth with environmental sustainability.

Second, the government must prioritize the development of green logistics infrastructure by continuously reviewing and aligning logistics plans with sector goals. The government should attract investment in centralized logistics centers to optimize distribution. Additionally, the government needs to foster regional green trade by sharing best practices through bilateral and multilateral free trade agreements. Budget allocations for research and technology in green logistics are crucial. Investments in infrastructure for electric vehicles, green warehousing, and smart logistics technology will enable

ASEAN to leverage its economic and demographic strengths, enhance competitiveness, and capitalize on the region's large population for improved production and export strategies.

Third, the government should establish a green logistics capability index to measure and monitor development, guiding effective solutions. The government must set standards for the express delivery industry to enhance efficiency and customer compensation, integrating green practices like eco-friendly transportation and digital tracking systems. Improving international cargo transportation timeliness will boost the GLPI and support intra-ASEAN trade. The government should establish dialogue mechanisms within ASEAN to refine logistics routes and service responses.

Fourth, businesses need to increase their awareness of green logistics' environmental benefits and regularly update strategies to align with practical realities. Businesses should upgrade to environmentally friendly vehicles, optimize warehousing with GPS technology, and enhance cold storage to improve energy efficiency. Adopting green packaging, sustainable transportation, and improved supply chain practices will help businesses gain a global competitive edge and align with environmental policies.

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Research on Factors Affecting the Development of the Cinnamon Value Chain in Thai Nguyen province, Vietnam

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Abstract

Developing cinnamon is an effective solution that contributes to minimizing the impact of climate change, simultaneously the cultivation of cinnamon currently provides a livelihood for farming households in remote areas of Vietnam. Thai Nguyen province is a major producer of cinnamon, with production largely concentrated in the Dinh Hoa and Vo Nhai districts. However, expanding cinnamon production faces significant challenges. To analyze the factors influencing the development of cinnamon value chain in Thai Nguyen province, a study was conducted based on data collected from 343 farmer households using reliability analysis tools such as Cronbach's Alpha coefficient, EFA exploratory factor analysis, and a linear regression model. The analysis revealed seven key factors affecting cinnamon value chain including Economic efficiency of cinnamon production of farmer households, policies to support cinnamon development, Links between actors in the chain, and Cinnamon product consumption market strongest impact on cinnamon development. The study recommends comprehensive solutions to promote cinnamon production and consumption, including refining policies to support cinnamon development, rural infrastructure development, supplying inputs for production, promoting links between actors in the chain and ensuring reasonable distribution of benefits among actors in the chain, improving economic efficiency and promoting output markets for cinnamon products.

Keywords: *Cinnamon, cinnamon industry, development, influencing factors, value chain*

1. Introduction

Cinnamon is a crop with high economic value and is suitable for some mountainous areas. Most parts of the cinnamon tree can be used to process into many valuable products and bring high economic efficiency, increase forest cover and contribute to protecting the ecological environment. Decision No. 1748/QD-TTg dated December 30, 2023, on the Crop Development Strategy to 2030, with a vision to 2050, clearly stated that developing crop production according to the value chain, associated with cooperative development and market orientation based on close links between partners. In Thai Nguyen province, cinnamon is a key crop according to Decision No. 139/QD-UBND of the People's Committee of Thai Nguyen Province. Cinnamon is considered suitable for production practices and soil and climate conditions and is grown in two districts: Dinh Hoa and Vo Nhai. Developing cinnamon according to the chain model linking farmers with other economic entities is being promoted by Thai Nguyen province. However, in recent years, the production, processing and consumption of cinnamon has encountered many difficulties. There are many reasons leading to the current challenges in the development of the cinnamon industry in Thai Nguyen province, in which the price and quality of cinnamon products between times and regions are still different. The value of products at different stages in the consumption chain is also different. Linking to consume cinnamon products in the chain is difficult, the link between farmers and businesses and traders is still too little, the level of connection is still "loose" and the interests of all parties have not been determined harmoniously. The level and production capacity of farmers are still weak. The output for agricultural products is still unstable (Hien, 2022). Lack of market information is also the reason why cinnamon producers are always passive when participating in the market. Current state policies are not yet consistent . The value chain is constrained by many factors such as product characteristics, characteristics of production activities, links between actors in the chain, policies and characteristics of the market. The change of these factors leads to changes in the production and distribution methods of the actors participating in the value chain (Tuoi, 2022; Ha, 2023). Research to find out the factors affecting the cinnamon production and consumption chain will increasing income for cinnamon growers and increasing the value of the cinnamon value chain in Thai Nguyen province.

2. Literature review

2.1. Theoretical basis for developing industry value chains

Research based on the value chain approach (Gereffi, 1999; Porter, 1985) and the ValueLinks value chain approach of GTZ in 2007 has been applied in the study of value chain industries to propose solutions to improve the chain. The study on the retail value chain of fresh fruits and vegetables proposed solutions for chain development such as creating a favourable environment for private investment, setting standards for products to maintain quality, post-harvest management, developing skilled human resources and infrastructure, especially developing linkages between small farmers and retailers (Reddy's, 2010). In Vietnam, the factors affecting the medicinal value chain in Yen Thuy district, Hoa Binh province such as policies, qualifications of actors participating in the chain, linkages between actors in the value chain, consumer market, science and technology and natural conditions (Minh & Son, 2014). The study on the model of developing organic cinnamon according to the value chain in Yen Bai province clarified the current status of developing some linkage models in developing organic cinnamon; Identifying limitations in the linkage chain between farmers and other entities in each linkage chain (Ha, 2023). The research in Lam Dong province proposed solutions to help develop and upgrade the value chain of the Arabica coffee industry in Lam Dong, focusing on solutions to strengthen linkages between actors, improve product quality, change policies and invest in technology (Tuoi, 2022).

2.2. Independent variable

State policies (SP): These are appropriate policies to promote the close connection between cinnamon-growing households and collection, processing and consumption facilities through the harmonious coordination between farmers, businesses, scientists and the State, creating cohesion for the common benefit of the whole community. The State management includes policies that affect the consumption chain of cinnamon products in Yen Bai province (Quyet, 2017). The group of policy factors shows the management capacity of state agencies, the level of state investment in infrastructure for medicinal plant development and the participation of organizations and associations to expand the market and develop agriculture (Lio & Liu, 2008). In addition, the research examines the role of State policies that positively impact the Vietnamese pharmaceutical industry, helping the Vietnamese pharmaceutical industry develop and grow (Loan, 2024).

Hypothesis 1: State policies affect the development of the cinnamon value chain in Thai Nguyen province

Economic efficiency of cinnamon production by farmers (EC): The economic efficiency of farmers is expressed by their output, revenue and income after the production process compared to expectations. Research by Tran Van Quyet in 2017 shows that the economic efficiency of farmers affects the cinnamon consumption chain in Yen Bai province.

Hypothesis 2: The economic efficiency of cinnamon production by farmers affects the development of the cinnamon value chain in the Thai Nguyen province

Linkage between actors in the chain (LK): Linking production to gain strength and solve problems that a small-scale individual producer cannot do. Small-scale production with small quantities cannot create strengths in negotiations, and bargaining, and is very disadvantageous when negotiating. Therefore, producers must find ways to link to gain strengths from the majority. Linking production will have benefits. Studies on value chains have shown that when members cooperate and link together, the chain is more sustainable and brings more economic and social efficiency; trust between subjects demonstrates the sustainability of the chain. The linkage between agents in the medicinal value chain, strengthening the linkage between agents is also one of the solutions proposed by studies in the analysis of the coffee value chain (Hanh & Diem, 2017; Boaventura et al., 2018; Thu, 2022).

Hypothesis 3: Linkages between actors in the chain affect the development of the cinnamon value chain in Thai Nguyen province.

Benefit sharing among actors in the chain (BE): Nguyen Thi Yen Linh's study in 2023 shows that profit sharing is unfair to livestock farming households, and the connection between actors in the chain is spontaneous and fragmented, creating low economic efficiency.

Hypothesis 4: Benefit sharing among actors in the chain affects the development of the cinnamon value chain in Thai Nguyen province

Infrastructure (IS): Infrastructure in agricultural production includes transportation systems; lighting systems; irrigation systems; logistics port systems... The more developed the infrastructure, the more benefits it brings to the creation and development of links between farmers and entities. Convenient locations near the market, near the road and the development of the transportation system, have been proven in previous studies to be factors that have a positive impact on sustainable development (Teruel & Kuroda, 2005). Investment in infrastructure such as irrigation systems has been shown to have a positive impact on agricultural productivity (Zepeda, 2001).

Hypothesis 5: Infrastructure affects the development of the cinnamon value chain in Thai Nguyen province

Consumption market (CO): The group of market factors include the supply and demand relationship of medicinal plants, the export of medicinal plants and the domestic consumption demand for medicinal products (Hoa, 2014). In theory, the supply and demand relationship is affected by prices, the export depends on the world consumption demand, the quality of medicinal products and the product brand, while the domestic consumption demand depends on the scale of the domestic market, consumption habits and product quality. The chain linkage is necessary to share technical and market information between stages and help self-adjust so that the chain operates in a market-oriented manner. To sell products at reasonable prices, it is necessary to see what type of products customers need and what standards they need to gradually meet (Thu, 2022). Only by producing agricultural products according to market demand can we increase the selling price, thereby increasing profits (Hoan, 2023).

Hypothesis 6: The consumption market affects the development of the cinnamon value chain in Thai Nguyen province

Input factors (IF): In the cinnamon industry, input factors such as seeds, supplies, specialized chemicals, raw materials, etc. of production agents are considered extremely important, they determine the stability and development of the entire value chain in the industry. Research by Nguyen Van Trong in 2017 has shown that input factors have a positive impact on the development of the Son Tra value chain.

Hypothesis 7: Input factors affect the development of the cinnamon value chain in Thai Nguyen province

3. Methods

Secondary data were collected at the Thai Nguyen Provincial Statistics Office, the Department of Agriculture and Rural Development of Thai Nguyen Province and published documents. Primary data were collected in two cinnamon growing districts of Thai Nguyen Province, Dinh Hoa District and Vo Nhai District. The total number of cinnamon growing households in Thai Nguyen is 953, of which 870 households grow cinnamon in Dinh Hoa District and 83 households grow cinnamon in Vo Nhai District. The sample size calculated by the Slovin method is 343 households, randomly selected from 274 cinnamon growing households in Dinh Hoa District and 69 households from Vo Nhai District for direct interviews in 2023. To ensure the accuracy of the information, interviews were conducted with the household head or the second most important member of the family who is directly involved in production. The study used the value chain analysis method according to Porter's theory (1985), to examine the actors participating in the chain (from the input supply stage to the production process, to the collection, preliminary processing and consumption of products) and analyze the flow of products from the production site to the consumption site through different channels.

To measure the attitudes and evaluation levels of the survey participants, the study used the Likert scale with the following 5 common levels: (1) Strongly disagree; (2) disagree; (3) neutral; (4) agree; (5) strongly agree. SPSS 20 software was used as a tool to support the research. The preliminary assessment of the reliability and value of the scale was carried out using the Cronbach alpha reliability coefficient method and the EFA (Exploratory Factor Analysis).

4. Results and Discussion

4.1. Data Collection

This survey was conducted with 343 samples, with the majority being male (84.3%), the majority being aged 31-40 (44.3%).

Table 1: Profile of respondents

Measure	Value	Frequently (Percentage)	Measure	Value	Frequently (Percentage)
1. Gender	Male	289 (84,3%)	**3.Education level**	Primary school	1 (0,3%)
	Female	54 (15,7%)		Junior high school	12 (3,5%)
2. Age	<20	0		High school	201 (58,6%)
	21-30	64 (18,7%)		Undergraduate	118 (34,4%)
	31-40	152 (44,3%)		Postgraduate	11 (3,2%)
	41-50	75 (21,9%)	**4.Location**	Dinh Hoa	274 (79,9%)
	>50	52 (15,%)		Vo Nhai	69 (20,1%)
Total number of respondents=343					

Source: Author's survey data in 2023

4.2. Cinnamon industry value chain

According to the research results, 65% of cinnamon is sold by farmers to processing facilities through collectors, and about 35% of cinnamon is sold directly by farmers to processing facilities through production contracts between enterprises and farmers. From processing facilities, 30% is sold to domestic wholesalers, 50% is sold to foreign traders, and the remaining 20% is sold directly to retailers and end consumers.

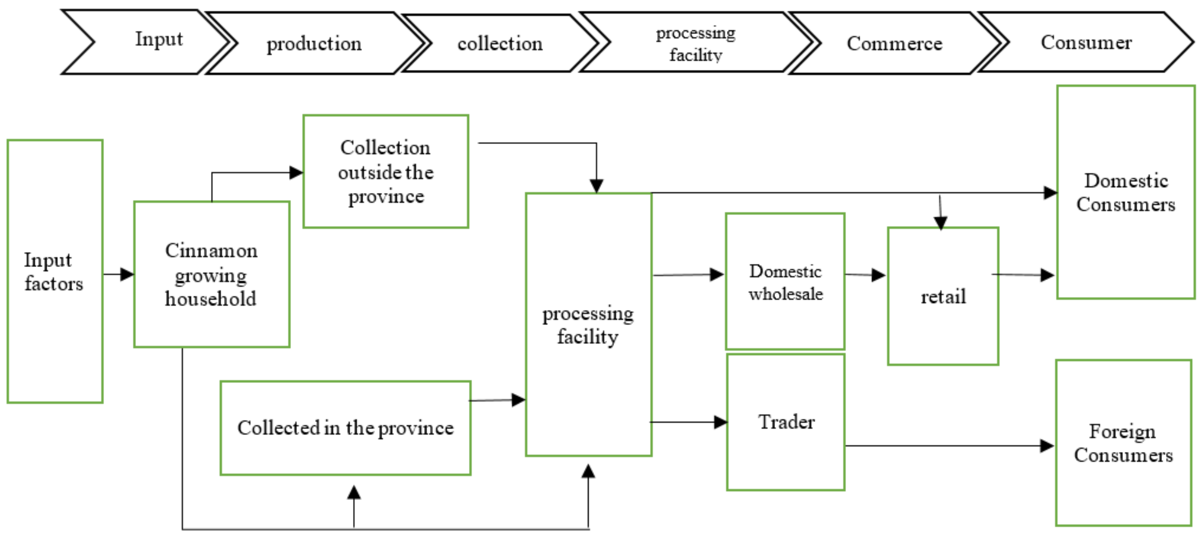

Figure 1: Value chain diagram of cinnamon industry in Thai Nguyen

Source: Author's survey data in 2023

4.3. Factors affecting the development of cinnamon industry value chain

4.3.1. Measurement scale checking

The results of Cronbach's Alpha evaluation are shown in Table 2, showing that all scales meet the requirements (Cronbach's alpha coefficient > 0.6), and the observed variables all have variable-total correlation coefficients > 0.3. Therefore, all scales are reliable.

Table 2: Exploratory factor analysis

Constructs	Factor loading	Mean	SD	Cronbach 'salpha
State policy (SP)				
SP1: The government has many policies to support actors	.832	3.40	1.079	.783
SP2: Policy mechanisms facilitate actors	.848	3.51	1.048	
SP3: Policy mechanisms bring many benefits to actors	.811	3.45	1.021	
Economic efficiency of cinnamon production by farmers (EC)				
EC1: Cinnamon output is higher than expected	.819	3.66	.959	.752
EC2: Cinnamon revenue is higher than expected	.826	3.83	.967	
EC3: Cinnamon income is higher than expected	.801	3.56	.965	
Linkage between actors in the chain (LK)				
LK1: Links between actors are tight	.845	3.46	1.010	
LK2: Actors support each other	.811	3.33	1.002	.862
LK3: Actors share benefits	.857	3.40	1.029	
LK4: Actors share risks	.836	3.42	1.031	
Benefit sharing among actors in the chain (BE):				
BE1: All actors are equally distributed benefits	.849	3.58	1.008	.803
BE2: All actors are expected to increase benefits	.866	3.80	1.000	
BE3: Actors are satisfied with the distribution of benefits	.818	3.54	.972	
Infrastructure (IF)				
IF1: Infrastructure meets the requirements for cinnamon industry development	.800	3.36	.903	
IF2: Infrastructure is favorable for cinnamon industry development	.823	3.46	.897	.765
IF3: Infrastructure is increasingly invested in and developed				
	.835	3.36	.901	
Consumption market (CO)		3.37	1.165	
CO1: Cinnamon product consumption market meets supply	.852			
CO2: Cinnamon products are consumed very conveniently and easily		3.29	1.039	.830
CO3: Cinnamon product prices are reasonable	.862	3.72	1.181	
	.874			
Input Factors (IS)				
IS1: Input Factors Ensure Quality	.774	3.82	.925	.669
IS2: Input Factors Have Reasonable Prices	.738	3.56	1.049	
IS3: Input Factors Always Have Guaranteed Supply	.806	3.77	.910	
Developing the Cinnamon industry value chain (DP)				
DP1: Developing the cinnamon industry value chain is increasingly expanding		3.62	.589	
DP2: Developing the cinnamon industry value chain has many advantages		3.61	.601	.646
DP3: Developing the cinnamon industry value chain brings many benefits		3.64	.595	

Source: Author

4.3.2. Exploratory Factor Analysis

* *KMO coefficient and Bartlett test*: In theory, the KMO coefficient (Kaiser-Meyer-Olkin) must reach a value of 0.5 or higher ($0.5 \leq KMO \leq 1$). From the processed data, the KMO coefficient = 0.708 satisfies the test conditions. At the same time, the sig value <0.05 satisfies the Bartlett test conditions (Table 3).

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.708
Bartlett's Test of Sphericity	Approx. Chi-Square	2448.563
	df	231
	Sig.	.000

Source: Author

* *Rotated Factor Matrix*: Observing the data of factor rotation matrix analysis, we see no disturbance of observed variables, observed variables all have factor loading greater than 0.5 (table 2), and no observed variable loads on multiple factors with the difference in loading factor less than 0.2. Total extracted variance 69.657% > 50% at eigenvalues 1.644 > 1. Observed variables converge on 7 latent factors. Therefore, the EFA results are reliable and can used for regression analysis in the next step.

4.3.3. Regression analysis

* *Correlation coefficient*: Through the Pearson correlation results, it can be seen that the dependent variable has a linear correlation with all independent variables SP, EC, LK, BE, IF, CO and IS (sig value is less than 0.05). Comparison between independent variables does not show multicollinearity (Pearson correlation coefficient < 0.7).

Table 4: Correlations

	SP	EC	LK	BE	IF	CO	IS
SP	1	-.005	.075	.066	.098	.018	.135*
EC	-.005	1	-.048	.076	-.034	.045	.038
LK	.075	-.048	1	-.027	.119*	.034	.042
BE	.066	.076	-.027	1	.009	.046	.016
IF	.098	-.034	.119*	.009	1	.068	.092
CO	.018	.045	.034	.046	.068	1	.028
IS	.135*	.038	.042	.016	.092	.028	1
*. Correlation is significant at the 0.05 level (2-tailed).							
**. Correlation is significant at the 0.01 level (2-tailed).							

Source: Author

* *Regression model testing and research hypothesis testing*: The adjusted R-squared value is 0.663, showing that the 7 independent variables used in the regression model explain 66.3% of the variation in the dependent variable, the remaining 33.7% is due to the influence of variables outside the model and random errors. The Durbin-Watson (DW) coefficient is used to check the correlation of adjacent errors. From the above results, DW = 2.045 is in the range from 1 to 3, so there is no first-order serial autocorrelation (Table 5).

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.819[a]	.670	.663	.26435	.670	97.141	7	335	.000	2.045

a. Predictors: (Constant), SP, EC, LK, BE, IF, CO, IS
b. Dependent Variable: DP

Source: Author

The results of ANOVA analysis of variance (Table 6) show that the F test has a significance level of Sig. = 0.000 (< 0.05), meaning that the group of independent variables has a linear correlation with the dependent variables.

Table 6: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47.518	7	6.788	97.141	.000[b]
	Residual	23.410	335	.070		
	Total	70.928	342			

a. Dependent Variable: DP
b. Predictors: (Constant), SP, EC, LK, BE, IF, CO, IS

Source: Author

* *Hypothesis Testing*: Explain the results of finding the hypothesis test at 5% significance level in the Table 7.

Hypothesis 1: State policy affects the development of the cinnamon value chain in Thai Nguyen province. Table 7 shows that State policy positively affects the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.304$, $p = 0.000$). Therefore, hypothesis H1 is accepted.

Hypothesis 2: Economic efficiency of cinnamon production by farming households affects the development of the cinnamon value chain in Thai Nguyen province. Table 7 shows that the economic efficiency of cinnamon production by farming positively affects the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.362$, $p = 0.000$). Therefore, hypothesis 2 is accepted.

Hypothesis 3: Linkages between actors in the chain affect the development of the cinnamon value chain in Thai Nguyen province. Through Table 7, it can be seen that the linkage between actors in the chain has a positive impact on the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.289$, $p = 0.000$). Therefore, hypothesis 3 is accepted. The results of the study prove that the above hypothesis is correct, there is a loose linkage in the trade relationship between actors in the chain, the scale of production is small and fragmented, there is a lack of effective mechanisms to ensure the implementation of commitments in transactions, horizontal linkages have not been formed, the role of scientists and the state is still weak, processing technology is not high, processing capacity has not been maximized, processed products are still mainly raw products,

Hypothesis 4: The division of benefits between actors in the chain affects the development of the cinnamon value chain in Thai Nguyen province. Through Table 7, it can be seen that the division of benefits among actors in the chain has a positive impact on the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.227$, $p = 0.000$). Therefore, hypothesis 4 is accepted. The results of the survey and interviews with processing facilities, along with management agencies, show that these actors also want to link together to unify the purchase price, avoid price increases, compete for sources of goods from farmers, collection facilities, and especially the selling price of products to foreign wholesalers and exporters.

Hypothesis 5: Infrastructure affects the development of the cinnamon value chain in Thai Nguyen province. Infrastructure in agricultural and forestry production includes traffic systems; lighting systems; irrigation systems; logistics port systems... The more developed the infrastructure, the more benefits it brings to the creation and development of links between farmers and entities. Table 7 shows that infrastructures positively affect the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.241$, $p = 0.000$). Therefore, hypothesis 5 is accepted.

Hypothesis 6: The consumption market affects the development of the cinnamon value chain in Thai Nguyen province. Table 7 shows that the consumption market positively affects the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.295$, $p = 0.000$). Therefore, hypothesis H6 is accepted. The research results also prove that the above hypothesis is correct, some processed products are too dependent on the Chinese market, there is an imbalance in raw materials for processing within the province, and the capital capacity to upgrade technology is still poor.

Hypothesis 7: Input factors affect the development of the cinnamon value chain in Thai Nguyen province. Table 7 shows that input factors have a positive impact on the development of the cinnamon value chain in Thai Nguyen province ($\beta = 0.209$, $p = 0.000$). Therefore, hypothesis 7 is accepted.

Among the factors affecting the development of the cinnamon value chain in Thai Nguyen province, the independent variable Economic efficiency of cinnamon production of farming households has the highest impact because it has the highest standardized regression coefficient ($\beta = 0.362$), followed by the independent variables State policy ($\beta = 0.304$), consumption market ($\beta = 0.295$), linkages between actors in the chain ($\beta = 0.289$), infrastructures ($\beta = 0.241$), benefit sharing between actors in the chain ($\beta = 0.227$) and input factors have the weakest impact ($\beta = 0.209$). Since the β coefficients are all positive, these independent variables all have a positive effect on the dependent variable. In addition, the VIF coefficients of the variables are all less than 2, so there is no multicollinearity. Thus, we have the regression function representing the factors affecting the development of the cinnamon industry value chain as follows: **DP = 0.304*SP + 0.362*EC+ 0.289*LK + 0.227*BE + 0.241*IF + 0.295*CO + 0.209*IS + e**

Table 7: Hypothesis test results

Hypothesis		Beta	Result
H1	State policies affect the development of the cinnamon value chain in Thai Nguyen province	.304	Supported
H2	The economic efficiency of cinnamon production by farmers affects the development of the cinnamon value chain in the Thai Nguyen province	.362	Supported
H3	Linkages between actors in the chain affect the development of the cinnamon value chain in Thai Nguyen province.	.289	Supported
H4	Benefit sharing among actors in the chain affects the development of the cinnamon value chain in Thai Nguyen province	.227	Supported
H5	Infrastructure affects the development of the cinnamon value chain in Thai Nguyen province	.241	Supported
H6	The consumption market affects the development of the cinnamon value chain in Thai Nguyen province	.295	Supported
H7	Input factors affect the development of the cinnamon value chain in Thai Nguyen province	.209	Supported

Source: Author

5. Conclusion

The study has shown that the cinnamon value chain in Thai Nguyen includes input factors for production, cinnamon production by farmers, cinnamon product collection, processing facilities, trade and cinnamon product consumption market. The study has also identified 7 factors and the level of influence of each factor on the development of the cinnamon value chain in Thai Nguyen province, Vietnam. These factors include the economic efficiency of cinnamon production, linkages between actors in the chain, state policies in cinnamon development, benefit sharing between actors in the chain, infrastructure, consumption market and input factors for production. Of these, 4 factors: Economic efficiency, policy support, and linkages between actors in the chain and cinnamon product consumption market are the factors that have the greatest influence on the development of the cinnamon value chain in Thai Nguyen. The study recommends that to develop cinnamon production in Thai Nguyen province in particular and Vietnam in general, the Government, Thai Nguyen province need to coordinate to develop strategic plans, build and form horizontal links between actors in the value chain by establishing associations for each group of actors. It is necessary to promote vertical linkages with the supporting and management roles of local authorities, strengthen closer ties between actors through contract mechanisms, promote restructuring of the system of cinnamon product processing facilities, and increase propaganda about the benefits of the product consumption chain. In addition, it is necessary to apply complementary solutions such as strengthening production organization, technological innovation, market and product positioning, trade promotion, trade policy and capital. In addition, it is necessary to pay attention to re-planning the growing areas, issuing specific policies, diversifying product types and output markets, and regularly updating technical advances in production and processing products to improve economic efficiency in cinnamon production.

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Green Human Resource Management: A case study of Economic Groups in Vietnam

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Abstract

The world has been increasingly witnessing more negative impacts of economic development on the environment. Protecting the environment is considered a collective responsibility of society as a whole. For businesses, environmental protection relates to their competitiveness and long-term success. Therefore, businesses must integrate environmental protection goals into their management activities, including human resource management. Green human resource management (GHRM) refers to human resource practices with thư aim of environmental protection objectives. This paper investigates green human resource management at economic groups in Vietnam. To achieve its research objectives, the paper employs quantitative methodologies including reliability analysis via Cronbach's Alpha, exploratory factor analysis (EFA), and regression analysis. The survey sample encompasses 384 employees across five prominent economic groups in Vietnam. The research findings show five core components of GHRM, which are: green recruitment and selection, green training, green performance management, green pay and reward, and green involvement, as well as the relative contribution of each component towards achieving environmental benchmarks in human resource management.

Keywords: *Environment, green human resources management, economic groups*

1. Introduction

Sustainability has become a pressing global issue and businesses increasingly concerned about the impact of environmental problems on their competitiveness and long-term success (Paillé et al., 2014). Sustainability demands that businesses focus not only on economic objectives but also on environmental and social concerns; not just short-term goals but long-term aims as well. Addressing environmental objectives and harmonizing economic development with environmental protection has given rise to the concept of green growth: green economic growth, green production, green development, green resources, green governance, and so on. To make their operations more environmentally - friendly, businesses need to change how they utilize resources, especially human resources, as these play a crucial role in determining a company's competitive advantage and operational efficiency. Hence, prioritizing green initiatives within human resource management is paramount to achieving sustainable development objectives. The demand for integrating green principles into HRM is growing, giving rise to the concept of Green Human Resource Management (GHRM) (Mishra et al., 2014).

As environmental issues (greenhouse gas emissions, global warming, ozone depletion, etc.) continue to escalate, and with empirical evidence demonstrating the relationship between human management and addressing environmental problems, the green HRM trend is becoming increasingly prevalent in organizations. Studies investigating the link between HRM and environmental protection goals are also growing more numerous (Jackson et al., 2011; Das & Sreelakshmi, 2021; Aftab et al., 2023; Tang et al., 2018), and so on. The research by (Daily & Huang, 2001) and (Jackson et al., 2011) has proven that human resources are pivotal in achieving successful environmental management. The findings of (Daily & Huang, 2001) also indicate that, with regard to environmental protection, GHRM can facilitate the successful establishment and implementation of environmental management initiatives by aligning activities such as recruitment, performance evaluation, and training with environmental objectives. GHRM positively impacts sustainable operational efficiency, with the most pronounced influence on environmental sustainability (Mousa & Othman, 2020). Despite the substantiated contribution of HRM to environmental conservation in numerous studies and the growing corpus of literature on GHRM, a cohesive understanding of GHRM and standardized measurement tools for evaluating GHRM in enterprises are still lacking (Tang et al., 2018). This underscores the imperative for further research and enhancement of GHRM measurement instruments.

Economic groups are defined as "a group of companies with relationships to each other through share ownership, capital contribution, or other forms of association" (Quốc Hội, 2020). In other words, economic groups are formed through investment activities and collaborative contracts, with a complex multi-tiered organizational structure. In Vietnam, economic groups can be divided into two groups: state-owned economic groups established by the Prime Minister's decision (10 groups) and privately-owned economic groups (more than 20 groups). Economic groups in Vietnam have leveraged their advantages of scale, outperforming small and medium-sized enterprises in terms of knowledge, resources, and profitability if these groups make a success. In the field of human resource management, the methods and practices employed by these groups have also achieved superior outcomes compared to other types of enterprises and organizations (Do Vu Phuong Anh et al., 2022).As a result, the implementation of green human resource management also benefits from more favorable conditions and a more conducive environment compared to other organizational structures.

This article aims to investigate the practice of Green Human Resource Management (GHRM) at economic corporations in Vietnam. Based on the inheritance of GHRM scales and their application in the practices of economic corporations in Vietnam, the article addresses the research question, "*Have human resource management activities in economic corporations in Vietnam met green criteri*a?" The author selects economic corporations for study because they have the advantage of capital, labor, revenue, scope of operations, and influence on economic, social, and environmental issues. The author expects that with such large scope, economic corporations can sponsor more activities of enviromental protection. Additionally, the management competency and quality of human resources in large economic groups are assessed as a favorable factor for implementing GHRM activities in enterprises.

This paper makes certain academic contributions and policy implication. Firstly, this paper clarifies the concept of GHRM and criteria for measuring GHRM in enterprises. Secondly, the paper presents findings on the practical measurement of GHRM in Vietnam's economic groups and discusses those results. Finally, it provides policy implications and suggestions for future research. The paper is divided into the following sections: Research overview, Methodology, Findings, Discussion, and Conclusions.

2. Methods

2.1. Research model

To achieve the research objective of understanding GHRM practices in Vietnamese economic groups, the author employed a research model with 5 independent variables: green recruitment and selection (GRS), green training (GTT), green performance management (GPM), green pay and reward (GPR), green involvement (GII), and the dependent variable is GHRM. The author utilized the following general regression equation according to Ha Nam Khanh Giao (2019):

$$\mathbf{GHRM= \beta 1 + \beta 2GRS + \beta 3GTT + \beta 4GPM + \beta 5GPR + \beta 6GII + Ui}$$

(Ui is the random error term)

General regression function:

$$\mathbf{GHRM= \beta 1 + \beta 2GRS + \beta 3GTT + \beta 4GPM + \beta 5GPR + \beta 6GII}$$

2.2. Scale

The scale for GHRM components were derived and adapted from the scales by Tang et al. (2018). The author made minor wording and terminology adjustments to fit the Vietnamese context and culture. Based on 5 dimensions of GHRM - green recruitment and selection, green training, green performance management, green pay and reward, and green involvement - and the measurement scales for each component proposed in Tang et al. (tang 2018), the author obtained a total of 18 items. Additionally, the author proposed 2 items for green training and green pay and reward to include in the research. The ILO recommends that around 30% of human skills may become obsolete after 5 years, hence workers need continuous learning and skill development. On this basis, the author argues that green training should be conducted continuously in companies. Furthermore, the research by Renwick et al. (2013) and Tang et al. (2018) indicates that non-financial incentives are more effective in fostering green motivation among workers. Therefore, in addition to providing green benefits, companies need to utilize green criteria as a benchmark for employee performance evaluation and rewards within the organization. For the dependent variable "GHRM", the author used a single measurement scale for convenience in the research: "Human resource management activities in the company have achieved green criteria". The specific scales are presented in Table 1.

Table 1: The scale of variables

Variables	Scale	Source
Green recruitment and selection		
GRS1	We attract green job candidates who use green criteria to select organizations	(Tang et al., 2018)
GRS2	We use green employer branding to attract green employees	(Tang et al., 2018)
GRS3	Our firm recruits employees who have green awareness	(Tang et al., 2018)
Green training		
GTT1	We develop training programs in environment management to increase environmental awareness, skills and expertise of employees	(Tang et al., 2018)
GTT2	We have integrated training to create the emotional involvement of employees in environment management	(Tang et al., 2018)
GTT3	We have green knowledge management (link environmental education and knowledge to behaviors to develop preventative solutions)	(Tang et al., 2018)
GTT4	Green training is conducted continuously in our company	The author's proposal
Green performance management		
GPM1	We use green performance indicators in our performance management system and appraisals	(Tang et al., 2018)
GPM2	Our firm sets green targets, goals and responsibilities for managers and employees	(Tang et al., 2018)
GPM3	In our firm, managers are set objectives on achieving green outcomes included in appraisals	(Tang et al., 2018)
GPM4	In our firm, there are dis-benefits in the performance management system for non-compliance or not meeting environment management goals	(Tang et al., 2018)
Green pay and reward		
GPR1	We make green benefits (transport/travel) available rather than giving out pre-paid cards to purchase green products	(Tang et al., 2018)
GPR2	In our firms, there are financial or tax incentives (bicycle loans, use of less polluting cars)	(Tang et al., 2018)
GPR3	Our firm has recognition-based rewards in environment management for staff (public recognition, awards, paid vacations, time off, gift certificates)	(Tang et al., 2018)
GPR4	Environmental protection is used as a criterion for paying and rewards at our company.	The author's proposal
Green involvement		
GII1	Our company has a clear developmental vision to guide the employees' actions in environment management	(Tang et al., 2018)
GII2	In our firm, there is a mutual learning climate among employees for green behavior and awareness in my company	(Tang et al., 2018)
GII3	In our firm, there are a number of formal or informal communication channels to spread green culture in our company	(Tang et al., 2018)

Variables	Scale	Source
GII4	In our firm, employees are involved in quality improvement and problem-solving on green issues	(Tang et al., 2018)
GII5	We offer practices for employees to participate in environment management, such as newsletters, suggestion schemes, problem-solving groups, low-carbon champions and green action teams	(Tang et al., 2018)
Green human resources management		
GHRM	Human resource management in our company has achieved green criteria	The author's proposal

Sources: The author's summary

2.3. Methodology

To achieve the research objective of understanding GHRM practices in Vietnamese economic groups, the author employed a quantitative research method. Multiple linear regression analysis was used to measure the components of GHRM and the contribution of each component to the dependent variable "GHRM" in Vietnamese economic groups. To examine the appropriateness of the measurement scales used in the model, the author utilized Cronbach's Alpha analysis. Exploratory factor analysis (EFA) and multiple linear regression analysis with Pearson correlation coefficients were the main techniques that were used to analyze each relationship between GHRM components and the dependent variable "GHRM". To obtain data for the research, the author used a questionnaire survey. The survey respondents were employees working at 5 major economic groups in Vietnam: Viettel Military Industry and Telecoms Group, Vingroup, Vietnam Electricity Group, Vietnam Oil and Gas Group, and Hoa Phat Group. Each respondent was required to have a minimum tenure of three years within their respective economic group to ensure familiarity with the group's human resource management policies and green management practices. The sample size was determined using the rationale of Yamane (1967). Using Yamane's formula for an unknown population, with an expected error of 5%, the required sample size was calculated to be 384. The author selected 400 employees from the five major economic groups for the survey. By using the stratified random sampling method and the list of employees who have worked at the group for more than 3 years, provided by the groups, 80 employees were selected from each group to participate in the survey. A total of 384 valid responses were utilized for analysis. The survey structure was adjusted to ensure a balanced representation across groups based on criteria such as age, gender, professional qualifications, seniority, and job position. Data analysis and processing were conducted with the assistance of the SPSS specialized software.

3. Result

3.1. Assessment of reliability in the scale

The evaluation of scale reliability using Cronbach's Alpha reveals that both independent and dependent variables are larger than 0.7. The income variable (INC) has the highest Cronbach's Alpha of 0.912, while the environmental and working conditions variable (EWC) has the lowest Cronbach's Alpha of 0.842. With all variables surpassing the 0.7 threshold, they demonstrate unidimensionality and reliability, validating their continued utilization in the study (Hair, J.F., Black, W.C., Babin, B.J., & Anderson, 2010).

Table 2. Cronbach's Alpha Coefficient

No	Symbol	Factors	Cronbach's Alpha
1	GRS	Green recruitment and selection	0.824
2	GTT	Green training	0.720
3	GPM	Green performance management	0.707
4	GPR	Green pay and reward	0.700
5	GII	Green involvement	0.785

Sources: Processing from survey results

Moreover, the Cronbach's Alpha analysis results also showed that the observed variables all have a Corrected Item - Total Correlation coefficient, which is larger than 0.3. This shows that the scales are good and can be used to measure the components of GHRM in economic groups in Vietnam. The observed variables all have quite large Corrected Item - Total Correlation coefficients, with none exceeding the Cronbach's Alpha coefficient of the group. This suggests that the observed variables have a strong positive correlation with the remaining variables in the scale, the observed variable is good (Cristobal, E. et al., 2007). All variables were retained for exploratory factor analysis.

4.2. EFA analysis

Table 3. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.550	27.748	27.748	5.550	27.748	27.748	3.830	19.148	19.148
2	3.274	16.370	44.118	3.274	16.370	44.118	3.649	18.245	37.393
3	2.767	13.835	57.953	2.767	13.835	57.953	3.364	16.819	54.212
4	2.170	10.849	68.802	2.170	10.849	68.802	2.918	14.590	68.802
5	.958	4.788	73.590						
6	.875	4.375	77.965						
7	.547	2.735	80.699						
8	.478	2.388	83.088						
9	.435	2.173	85.260						
10	.388	1.940	87.200						
11	.348	1.740	88.940						
12	.326	1.629	90.569						
13	.310	1.552	92.121						
14	.278	1.388	93.508						
15	.264	1.321	94.829						
16	.245	1.223	96.052						
17	.218	1.092	97.144						
18	.217	1.084	98.228						
19	.191	.956	99.184						
20	.163	.816	100.000						

Extraction Method: Principal Component Analysis.

Sources: The author's research analysis

After testing the reliability of Cronbach's Alpha for the components of the scale, exploratory factor analysis (EFA) continued to be performed to analyze the exploratory factors. The EFA analysis is combined with the Principal axis factoring method and Promax rotation. The EFA analysis results showed: The KMO coefficient achieved as EFA analysis with the independent variables was 0.85, in the range of 0.5 to 1 (0.5 <KMO <1), allowing the conclusion that the independent variables meet sufficient conditions for exploratory factor analysis. The EFA results with the independent variables are accepted with the collected research data. The sig coefficient of the Bartlett's test reached 0.000 <0.05, proving that the observed variables in the factor are correlated with each other. The factor analysis results are suitable with 95% reliability. The Eigenvalues of the 5 components in GHRM reached 2.17 > 1, so all 5 components reflect the reality of GHRM in economic groups and were retained in the analysis model. The total extracted variance of the 5 components reached 68.802%, satisfying the condition of above 50% and indicating that the 5 components of GHRM explain 68.802% of the data variation.

The image of rotated component matrix in the EFA analysis shows that 20 observed variables converged into 5 factors, respectively: GRS - green recruitment and selection, GTT - green training, GPM - green performance management, GPR - green pay and reward, GII - green involvement. The observed variables have factor loadings, which are larger than 0.5 and no variable loads on multiple factors. Thus, the EFA analysis shows that there are 5 representative extracted components, and the 5 components as well as the component observed variables of each factor are consistent with the proposed research model.

Table 4: Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
GRS3	.818					
GRS2	.817					
GRS1	.814					
GTT1		.832				
GTT3		.808				
GTT2		.796				
GPM1			.902			
GPM4			.900			
GPM3			.899			
GPM2			.873			
GPR3				.851		
GPR4				.767		
GPR2				.764		
GPR1				.763		
GII5					.754	
GII2					.749	
GII3					.692	
GII1					.622	
GII4					.610	

Sources: The author's research analysis

4.3. Correlation analysis

Pearson correlation coefficient analysis was used to examine the linear correlations between the dependent variable and each independent variable, as well as among the independent variables themselves. The results show that with a significance level of 0.1, the independent variables are correlated with the dependent variable (GHRM), as evidenced by the Pearson Correlation coefficients and sig coefficients being 0.13 and 0.011 for GRS; 0.227 and 0.000 for GTT; 0.246 and 0.000 for GPM; 0.372 and 0.031 for GPR; 0.206 and 0.000 for GII, respectively. The low degree of correlation between the two independent variables is indicated by the Pearson correlation coefficient being lower than 0.5. This suggests that the regression model is quite appropriate.

Table 5: The result of Pearson correlation coefficient analysis

		GRS	GTT	GPM	GPR	GII	GHRM
GRS	Pearson Correlation	1	.304**	.094	.218**	.225**	.130*
	Sig. (2-tailed)		.000	.066	.000	.000	.011
	N	384	384	384	384	384	384
GTT	Pearson Correlation	.304**	1	.458**	.333**	.315**	.227**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	384	384	384	384	384	384

		GRS	GTT	GPM	GPR	GII	GHRM
GPM	Pearson Correlation	.094	.458**	1	.485**	.224**	.246**
	Sig. (2-tailed)	.066	.000		.000	.000	.000
	N	384	384	384	384	384	384
GPR	Pearson Correlation	.218**	.333**	.485**	1	.455**	.372
	Sig. (2-tailed)	.000	.000	.000		.000	.031
	N	384	384	384	384	384	384
GII	Pearson Correlation	.225**	.315**	.224**	.455**	1	.206**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	384	384	384	384	384	384
GHRM	Pearson Correlation	.130*	.227**	.246**	.372	.206**	1
	Sig. (2-tailed)	.011	.000	.000	.031	.000	
	N	384	384	384	384	384	384

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Sources: The author's research analysis

4.4. Regression analysis

Regression analysis displays the results in the tables:

In the Table 6 "**Model Summary**[b]", the adjusted R-squared value is 0.75, which satisfies the condition of being larger than 50%. This indicates that 75% of green criteria for human resource management in Vietnam's economic groups are measured by green recruitment and selection; green training; green performance management; green pay and reward; and green involvement. The remainder, 25% is determined by other factors outside the model. The Durbin-Watson coefficient = 1.776, which means that the errors do not have a first-order serial correlation with each other.

Table 6: Model summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.334[a]	.112	.750	.904	1.776

a. Predictors: (Constant), GII, GPM, GRS, GPR, GTT

b. Dependent Variable: GHRM

Sources: The author's research analysis

The analysis of variance results showed that the F-statistic, which is calculated from the model's R-squared value, has a very small sig value (sig = 0.000). This means that the linear regression model fits the dataset as a whole. On the other hand, the independent variables have a linear relationship with the dependent variable, and the model can be used.

Table 7: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.870	5	7.774	9.514	.000[b]
	Residual	308.870	378	.817		
	Total	347.740	383			

a. Dependent Variable: GHRM

b. Predictors: (Constant), GII, GPM, GRS, GPR, GTT

Sources: The author's research analysis

The Table 7 indicates that a significant level of five factors in GHRM is 0.000. This means that all independent variables are significant - they have an influence on the dependent variable. That VIF < 2 indicates that the research model does not suffer from multicollinearity.

Table 8: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.263	.283		7.996	.000
	GRS	.042	.069	.250	.609	.543
	GTT	.086	.090	.079	.958	.339
	GPM	.282	.074	.245	3.800	.000
	GPR	.194	.069	.172	2.800	.005
	GII	.224	.064	.194	3.482	.001

a. Dependent Variable: GHRM

Sources: The author's research analysis

According to the results of regression analysis, we have the linear regression equation based on unstandardized regression coefficients:

GHRM= 0.283 + 0.25GRS + 0.079GTT + 0.245GPM + 0.172GPR + 0.194GII

5. Discussion

With an F value of 0.000 < 0.001 in the regression analysis, it indicates that the overall regression model is statistically significant. The research model explains 68.802% of the variation in achieving green criteria in human resource management practices within Vietnam's economic groups. The independent variables are statistically significant in the overall model and fit the empirical research data.

A notable achievement of the research is demonstrating and measuring the five components of GHRM in Vietnam's economic groups, namely green recruitment and selection; green training; green performance management; green compensation and rewards; and green employee involvement. The quantitative research results also assess the practical significance of each component in implementing GHRM activities within the groups. Among the five GHRM components in Vietnam's economic groups, green recruitment and selection contributes the most to achieving green criteria of human resources governance, with a standardized regression coefficient of 0.25. Following that is green performance management with a standardized regression coefficient of 0.245; green employee involvement with a standardized regression coefficient of 0.194; green compensation and rewards with a regression coefficient of 0.172. Green training has the lowest standardized regression coefficient of 0.079, indicating its lowest level of contribution to achieving green criteria at economic groups in Vietnam; and all five components have a positive impact on GHRM implementation within these economic groups in Vietnam.

The results of the experimental analysis indicate that green recruitment and personnel selection are the most influential factors impacting Corporate Green Human Resource Development (GHRD). Economic groups in Vietnam could promote the activities of GHRM. By incorporating environmental management elements into recruitment and selection processes, companies can attract candidates who prioritize environmental considerations when selecting organizations, leveraging their green employer branding to attract employees. Once again, the research reaffirms the findings of Guerci et al. (2016) and Jabbour et al. (2008): "Companies with environmental orientations are more likely to recruit candidates with knowledge and motivation regarding the environment." Additionally, both Teixeira et al. (2016) and Jabbour et al. (2008) emphasize the importance of green training in GHRM. The study's results also demonstrate that Green Training and Development (GTT) is indeed a component of GHRM. However, current practices in economic groups in Vietnam show that GTT activities are not given sufficient emphasis. Moving forward, groups need to invest more in GTT to meet green criteria in their GHRM activities. Furthermore, investment in GTT brings numerous benefits to companies in terms of environmental protection, including creating a green environment where employees understand the significance of green training and environmental outcomes, conserving energy, reducing waste, and

providing opportunities to address environmental issues (Tang et al., 2018). However, environmental management training may not always yield successful outcomes because it is not directly related to the knowledge, skills, or attitudes of the workforce, or in other words, it is related to improving labor productivity – considered the most crucial goal of workforce training activities in enterprises.
Following green recruitment and selection, green performance management emerges as the second critical component of companies' GHRM. The study's findings align with the research of Zibbaras and Coan (2015) and Tang et al. (2018), indicating that Green Performance Management (GPM) is a vital aspect of GHRD. Therefore, economic groups in Vietnam need to invest in performance management activities such as evaluating the effectiveness of operations linked to environmental protection criteria, with a focus on the responsibility and outcomes of all members in environmental management.

Regarding payment and rewards, numerous studies have indicated that salary and rewards are the most critical factors in motivating employees (Alshmemri et al., 2017), (Herzberg, 1976), etc. Extending to the environmental management goals of the enterprise, it is evident that these objectives can be achieved through green compensation and rewards policies for employees. The article has demonstrated that green compensation and rewards are essential components of GHRM. Economic groups in Vietnam could achieve green criteria in human resource management activities through green compensation and rewards measures, such as providing green benefits, financial incentives, or tax incentives for green consumption activities, offering rewards for achieving environmental protection recognition, or considering environmental protection as a criterion for compensation and rewards within the company. The research findings of the article also align with the study by (Handgraaf et al., 2013), indicating that salary or rewards impact GHRM in companies.

The final component of GHRM addressed in the article is employee engagement. According to the experimental research results of the article, employee engagement is the third important component that helps corporations achieve green criteria in human resource management. The research findings are consistent with the findings of (Renwick et al., 2013) or (Tang et al., 2018). Additionally, as mentioned by Haddockmillar, Sanyal, and Mullercamen (2016), employee engagement in green activities is crucial for effectively implementing environmental strategies and policies - one of the significant challenges that organizations face today. Therefore, the research findings of the article are appropriate.

6. Conclusion

Using quantitative methods with multiple regression models and a survey scale of 384 respondents, the research results of the paper have clearly demonstrated the relationship between green recruitment and selection; green training; green performance management; green pay and reward; green involvement and GHRM in enterprises. The factors used in the model explained 68.802% of the variation in GHRM in Vietnamese economic corporations; the remaining 31.198% is explained by external factors outside the model. Theoretically, the paper once again confirms the suitability of the components constituting GHRM as well as the scale of those components. The five important components helping companies achieve GHRM criteria are green recruitment and selection; green training; green performance management; green compensation and rewards; employee green engagement. Correspondingly, 20 scales were inherited and developed. Practically, the research findings of the paper have suggested necessary activities for corporations to help them achieve green criteria in HRM activities. The research results of the paper can also broaden the perspective of managers in organizations; in environmental management, managers should consider all aspects of GHRM tested in this study.

However, the limitations of the paper are based on the assumption that economic corporations with strong financial resources, large scale, and high operational efficiency are more interested in environmental factors and can achieve green criteria in HRM. In reality, this assumption is not entirely correct; small businesses with good vision can also be concerned about environmental factors. Additionally, the scales of independent variables used in the new model only focus on aspects related to environmental protection rather than all aspects of the variables. For example, with the green recruitment and selection variable, the paper only uses three scales as proposed by (Tang et al., 2018): attracting candidates using green criteria to choose organizations, using green employer branding to attract employees, recruiting employees with green awareness, while the content of the recruitment activities also includes other factors such as recruitment policies, recruitment processes, identifying recruitment sources, etc. The authors argue that future research needs to address these limitations.

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Model for Studying the Impact of Green Human Resource Management on Employees' Green Behavior in the Food and Beverage Sector

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Abstract

This study focuses on constructing a theoretical model to explore how green human resource management influences employees' green behavior at food and beverage enterprises. Green human resource management focuses on the aspects of job description, green recruitment & selection, green training and development, green performance assessment, green reward & compensation, and green empowerment & participation. Green behavior includes mandatory behavior and voluntary behavior of employees in the workplace. The influence of green human resource management on green behavior is considered directly and indirectly through green organizational identification and individual green values. An in-depth interview method was employed to develop a theoretical model. The research findings provide a theoretical model and measuring scale for the variables in the research model. This serves as the foundation for the author's future quantitative research on the influence of green human resource management on green employee behavior in the food and beverage industries.

Keywords: *Green behavior, green human resource management, green organizational identification, individual green values*

1. Introduction

The majority of countries now face issues with environmental contamination as a result of the growth of modern industry. The challenge that this scenario presents is the urgent need to alter attitudes, behaviors, and ways of thinking, particularly with regard to altering certain ways of interacting with the natural world. This necessitates specialized adjustments and adaptations on a corporate and unit level, in addition to at the national level. Sustainability must be operationalized and included in organizations' plans, strategies, and daily operations. In order to provide a better and more sustainable future and to balance the development of the economy, society, and environment, this aids businesses in meeting the needs of stakeholders both now and in the future (Freire & Pieta, 2022).

Consumers are always interested in environmental and social responsibility issues at food and beverage enterprises (F&B). This industry's products have a direct impact on consumer health, and they are also thought to generate a significant amount of trash for the environment (Junsheng et al., 2020). According to statistics from the Ministry of Natural Resources and Environment (2020), Vietnam's F&B industry generates 1.8 million tons of plastic waste (plastic packaging, foam boxes, paper, and plastic straws). This leads to an increase in the amount of plastic waste from packaging, food containers, water bottles, straws, etc. These factors are prompting an increasing number of enterprises, particularly those in the food and beverage manufacturing industry, to encourage green development by integrating environmental and social obligations (Bansal & Song, 2017). Norton et al. (2016) noted that the implementation of green, pro-environmental policies in enterprises is heavily dependent on employee participation. The implementation of green behaviors by employees in the workplace not only contributes to improving the organization's environmental reputation, helping the organization gain a competitive advantage (Paillé et al., 2014), but also helps improve the living environment and contribute to the sustainable development of the society where they live (Norton et al., 2015). Because green behavior is so important, some studies are starting to focus on what organizational management strategies might encourage these habits (Chaudhary, 2020;

Shah & Soomro, 2023; Yuan et al., 2024; Zhu et al., 2021). Green human resource management (GHRM) encompasses HRM practices like performance evaluation, hiring, and training that are thought to be in line with the company's environmental objectives (Renwick et al., 2013) and can encourage environmentally conscious behavior among staff members (Yuan et al., 2024; Zhang et al., 2023). Consequently, in order to guarantee employees engage in ecologically friendly conduct at work, green HRM practices are crucial. Jiang et al. (2012) also argue that green human resource management directly and indirectly affects green behavior through different transmission mechanisms. This implies that the effects of green human resource management on green behavior may differ depending on the many mediating and regulating mechanisms. Furthermore, the scarcity of studies on the impact of green resource management on green behavior in food and beverage enterprises makes this a novel and intriguing topic. Therefore, in this study, the author focuses on building a model of the influence of green human resource management on the green behavior of employees at F&B businesses. The research findings contribute to a theoretical model of the direct and indirect effects (by mediating and moderating variables) of green human resource management on green employee behavior in F&B enterprises.

2. Theoretical framework

2.1. Green Human Resource Management-GHRM

As an essential component of the green management system, GHRM is a concept and a new management model that applies "green" management methods to human resource management. This is to achieve the strategic objective of corporate environmental management (Jabbour & Jabbour, 2016). The goal of GHRM is to foster green values, green knowledge, and green skills while also motivating employees through a series of complementary and coordinated activities like green recruitment, green training, performance evaluation, and green awards. Also, according to Kim et al. (2019), GHRM are activities related to job descriptions as well as the development of green competencies in recruitment, selection, training, green empowerment, evaluation, and reward of achievements. This helps promote employees' green behavior and environmental protection activities.

In this study, GHRM is defined as the application of "green" management practices to human resource management policies and activities in order to encourage environmentally conscious employee behavior. GHRM policies and practices include job descriptions, green recruiting and selection, green training and development, green performance appraisal, green rewards and benefits, empowerment, and green participation.

2.2. Green Behavior-GB

According to Ones and Dilchert (2012), GB are those that employees engage in that promote environmental sustainability. GB implements environmentally friendly workplace practices. Behaviors include learning and thinking about the environment, generating and applying ideas to lessen the negative impact of business on the environment, developing green products and processes, and recycling and reusing office equipment (Sarkis et al., 2013). GB refers to any voluntary (extra-role green behavior) or mandated (in-role green behavior) measures made by individuals to reduce negative environmental consequences and enhance sustainability (Paillé, 2013). Employee green behaviors in the workplace can take various forms, including waste reduction, energy and water conservation, the use of environmentally friendly products, recycling, and participation in environmental activities inside the firm.

In this study, GB is defined in this study as environmentally friendly employee activities such as energy conservation, garbage recycling, the usage of green products, and the implementation of initiatives to reduce the negative effects of human activities. To provide a holistic view of GB, this study considers both mandated and voluntary green behavior.

3. Literature review

3.1. Background theories

3.1.1. Ability - Motivation - Opportunity (AMO) theory

The widely recognized AMO model consists of three components: ability, motivation, and opportunities. These three criteria will influence total work efficiency. Initially, AMO was difficult to implement in human resource management. Because the AMO model can have an exponential effect, each variable must exist, and performance will rise or decrease in proportion to the movement of any variable (Siemsen et al., 2008). It was not until a later stage that the study of Appelbaum et al. (2000) became the standard reference for the AMO framework in the field of human resource management. Specifically, this author's view is that human resource management policies and practices can be grouped into capabilities, motivations, or opportunities and are linked to improved performance. The constituent elements in the AMO model are also explained and clarified. Ability can be understood as "the physiological and cognitive abilities that enable an individual to perform tasks effectively" (Blumberg & Pringle, 1982); or more generally, it is the knowledge, skills, abilities, and proficiency of employees (Kim et al., 2015). Motivation can be considered as a guiding force, energizing and maintaining behavior (Van Iddekinge et al., 2018); or an employee's willingness and desire to perform a task (Bos-Nehles et al., 2013). Finally, opportunity includes contextual or environmental factors that are beyond an individual's direct control, that exist around an individual, and that support or constrain an individual in performing a task (Blumberg & Pringle, 1982). This study approaches the AMO paradigm from the junction of the individual and organizational levels. The influence of green HRM practices on green corporate identity is specifically explained by the organizational level of AMO. At the individual level, AMO assists in elucidating green HRM practices to eco-conscious employees.

3.1.2. Social identity theory (SIT)

SIT has been associated with George Mead's name since the 1930s. However, this idea was not developed until the late 1970s and early 1980s by a group of academics, including Tajfel and Turner (1979). The theory's main content focuses on discussing an individual's feelings about themselves depending on the group to which they belong.

SIT theory is predicated on the idea that people who have views and consider themselves to be part of a geographical group expend a considerable amount of time and energy creating and maintaining a social identity. prestigious status and high standing (Tajfel & Turner, 1979). According to SIT theory, people invest a lot of time and effort into creating and maintaining a fulfilling social identity, and they do this because they believe and acknowledge that they belong to a high-status and prestigious group (Tajfel & Turner, 1979). Based on theoretical frameworks, emphasizing an organization's socially valuable norms and traits can increase employees' loyalty to the organization and help them feel important (Dutton et al., 1994; Tajfel & Turner, 1979). According to Ashforth and Mael (1989), employees who embrace the positive conduct and standards of their organizations are likely to exhibit a stronger sense of identification with them and a greater level of devotion to the organization.

In this study, SIT is used to imply that employees may think they will gain social and inter-organizational acceptance by adopting and putting into practice GHRM methods, hence developing a positive social identity. They may even feel more connected to the organization's environmental performance vision, and so GHRM activities may encourage the general development of green culture (Tandon et al., 2023). Such ideas will significantly improve their response to both voluntary and mandatory green behavior. As a result, SIT is used to explain an organization's GHRM efforts that promote green behavior among employees.

3.2. Literature review

Researchers have not given green human resource management-related studies much thought. Liu et al. (2020) studied GHRM in the industrial sector, using the moderating impacts of environmental values to identify green organizations and environmental organizational citizenship behavior. According to the findings, which are based on 201 sample elements from three manufacturing companies, GHRM significantly improves environmental organizational citizenship behavior. Furthermore, in the association between environmental organizational citizenship behavior and GHRM, the GOI variable acts as a moderator. Lastly, there is a moderating effect of environmental values on how green organizational citizenship behavior and GOI are affected by GHRM. Additionally, Shah and Soomro (2023) observed 190 personnel in the automobile business. Using structural equation modeling (SEM), the study discovers that green employee engagement, green compensation, green performance management, green training and development, and green recruitment all have a positive and significant effect on task-related green behaviors, voluntary green behaviors, and green innovation.

Regarding the same subject, Saeed et al. (2018) stressed the significance of green HRM in encouraging eco-friendly practices in Pakistani companies that deal with coal, chemicals, food, and medicines. Uslu et al. (2023) conducted a study with data collected from 425 employees working in 11 5-star hotels in Antalya/Manavgat district. Chaudhary (2019) investigated the influence of GHRM on improving the environmental performance of automotive sector employees in India.

According to the sources provided above, academics have recently focused on the impact of GHRM on employee performance. However, no research has been conducted on this problem in the F&B industry, particularly in Vietnam. Furthermore, the author's research found that no studies have investigated the indirect influence of GHRM on employee GB via the intermediate variable GOI and the moderating variable IGV.

4. Research model and Hypothesis development

4.1. Research model

In this study, the author used the information saturation approach to conduct in-depth interviews with five experts in the field (Creswell, 2014). After combining expert viewpoints, the author eliminated two detected variables. These two variables are part of the job description (GJD) and green recruitment and selection (GRS) indicators. Experts proposed adding seven observed factors, including six indicators for the GHRM variable and one for the GOI variable. The next stage of quantitative research begins with the editing of qualitative research data and the creation of a scale.

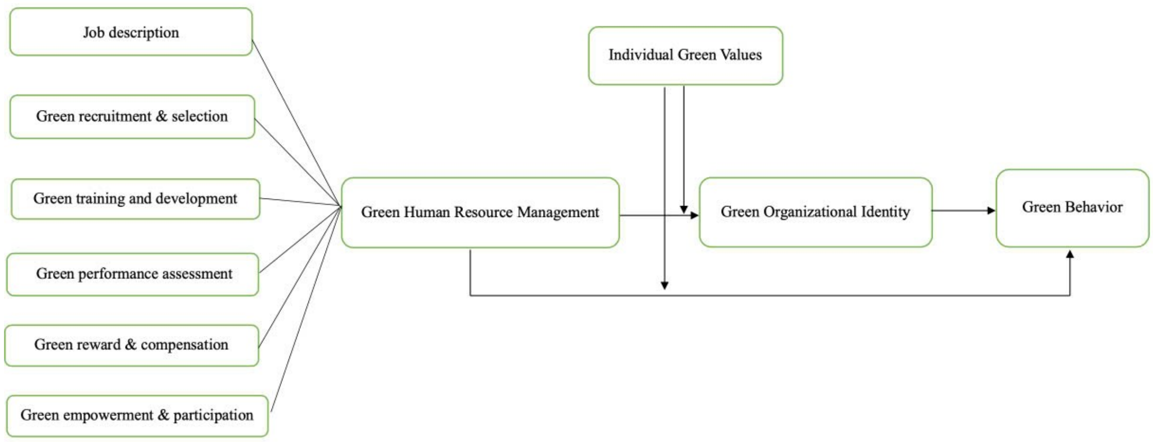

Figure 1: Proposed research model

Source: Authors

4.2. Hypotheses

4.2.1. The influence of green human resource management on green behavior

AMO theory can be used to describe the impact of GHRM on employees' GB. According to SVF theory, providing employees with green values through HR policies that align with IGV might increase their likelihood of engaging in green actions. According to SIT theory, GHRM approaches can also enhance the entire development of green culture, thereby strongly encouraging GB among the organization's personnel. The experimental results of Ribeiro et al. (2022); Yuan et al. (2024) suggest that green human resource management methods have a favorable impact on fostering green behavior among employees in organizations.

Hypothesis H_1: Green human resource management (GHRM) positively affects green behavior (GB).

4.2.2. The mediating role of green organizational identification in the influence of green human resource management on green behavior

According to SIT social identity theory, implementing GHRM policies provides a clear message to employees that the firm is committed to accomplishing environmentally friendly goals. This can help to foster a positive sense of self and human value within the organization (Rangarajan & Rahm, 2011), hence promoting the formation and growth of a green corporate identity. Furthermore, from an organizational standpoint, the AMO model demonstrates that human resource management operations are intended to improve organizational performance. This is used to explain how green human resource management influences green organizational identity. According to Liu et al. (2020); Zhu et al. (2021), green human resource management has a significant relationship with green organizational identification.

Hypothesis H_2: Green human resource management (GHRM) positively affects green organizational identity (GOI).

SIT theory suggests that green human resource management can be positively related to organizational identity and influence positive employee outcomes, such as environmentally friendly employee behavior (Gond et al., 2017). The study conducted by Ribeiro et al. (2022) shows that green human resource management can promote organizational identity, which in turn can promote environmentally friendly behavior in employees.

Hypothesis H_3: Green organization identification (GOI) positively affects green behavior (GB).

SIT theory also believes that the values, policies, management methods, etc. of an organization are transmitted inside and outside the organization, which will affect how employees perceive the organization. This will affect their intentions and behavior (Shen et al., 2016; Tajfel & Turner, 1979). According to SIT theory, employees tend to choose behaviors that are consistent with their organizational identification (Ashforth & Mael, 1989). Previous research has revealed that green organizational identity has a mediating role in boosting the favorable influence of green human resource management on employees' green behavior (Liu et al., 2020; Ribeiro et al., 2022).

Hypothesis H_4: Green organizational identification (GOI) plays a mediating role in the influence of green human resource management on green behavior (GB).

4.2.3. The moderating role of individual green value in the influence of green human resource management on green behavior

Based on SVF theory, which posits that employees perceive the organization's GRHM activities as sources of green value, and when their IGV align with these sources, they will demonstrate green behaviors toward the organization and community (Edwards, 1996; Tajfel & Turner, 1979). Several other researchers agree that personal green concerns, attitudes, and values influence environmental behavior (Casey & Scott, 2006).

Hypothesis H_5: Individual green values (IGV) play a positive moderating role in the influence of green human resource management (GHRM) on green behavior (GB).

GHRM activities demonstrate an organization's environmental values. Therefore, when an individual's environmental values coincide with the values of an organization, that person will demonstrate high levels of organizational identification and positive behavior (Dumont et al., 2017; Edwards & Shipp, 2007). Research by Liu et al. (2020) suggests that if an organization develops pro-environmental policies that are consistent with employee values, these employees are more likely to demonstrate positive attitudes.

Hypothesis H_6: Individual green value (IGV) plays a positive moderating role in the influence of green human resource management (GHRM) on green organizational identification (GOI).

Information about the variables in the model is presented specifically in Table 1. All expected scales in the study are used according to the levels of the 5-point Likert scale, "1-Strongly disagree", “2-Disagree”, “3-Neutral”, “4-Agree”, “5-Strongly agree”.

Table 1: Main constructs, items of variables

Construct	Items
Job description - GJD Jabbour (2011); Mousa and Othman (2020)	GJD1 - Job positions in our company enable involvement in environmental management activities; GJD2 - Job positions in our company enable the acquisition of knowledge about environmental management;

Construct	Items
	GJD3 - Job positions in our company demand knowledge about environmental management; GJD4 - Job description specification includes environmental concerns.
Green recruitment & selection - GRS Masri and Jaaron (2017); Renwick et al. (2013)	GRS1 - The environmental performance of the company attracts employees; GRS2 - HR department of our company prefers to hire employees that have environmental knowledge; GRS3 - Recruitment messages include environmental behavior/ commitment criteria; GRS4 - All selection steps consider environmental questions in our company; *GRS5 - The recruitment process and candidate profile management are digitized to save paper usage;* *GRS6 - A green working environment helps companies attract potential candidates.*
Green training and development-GTD Jabbour (2011); Masri and Jaaron (2017)	GTD1 - Environmental training is a priority in our company; GTD2 - My company provides induction training on environmental issues for the new employees; GTD3 - My company provides environmental awareness training for the employees; GTD4 - All training materials are available online for employees to reduce paper cost; GTD5 - HR department provides continuous, relevant, and effective environmental training programs.
Green performance assessment-GPA Masri and Jaaron (2017); Renwick et al. (2013)	GPA1 - Our company establishes green targets, objectives, and duties for each employee across organization; GPA2 - Employee's contribution to environmental management is included in performance appraisal; GPA3 - Employee's role in the achievement of green outcomes is included in performance appraisal; GPA4 - Managers are expected to give feedback to their subordinates on environmental initiatives; GPA5 - Environmental management objectives are incorporated into performance evaluation; *GPA6 - The company monitors/evaluates non-compliance or failure to achieve green goals in performance appraisals.*
Green reward & compensation-GRC Masri and Jaaron (2017)	GRC1 - Employees suggestions for innovative environmental initiative are rewarded; GRC2 - Employees are offered non-monetary and monetary rewards based on the environmental achievements; GRC3 - Environmental performance is recognized publically through awards, dinner, or publicity; *GRC4 - The company rewards individuals who have activities to promote/transmit green knowledge/messages to colleagues;* *GRC5 - The company provides transportation for employees to minimize the use of personal vehicles.*
Green empowerment & participation-GEP Masri and Jaaron (2017)	GEP1 - Our organization has introduced communication channels and helplines to support green initiatives; GEP2 - Top managers use teamwork to successfully manage and produce awareness of the environmental issues of the company; GEP3 - Our organization offers workshops or forums for staff to improve environmental behavior and exchange their tacit knowledge; GEP4 - Employees are involved in formulating our environmental strategy
Green organizational identification - GOI Chang and Chen (2013); Mittal and Dhar (2016)	GOI1 - The company’s top managers, middle managers, and employees are proud of the company’s history about environmental management and protection; GOI2 - The company’s top managers, middle managers, and employees have a sense of pride about the company’s environmental goals and missions; GOI3 - The company’s top managers, middle managers, and employees feel that the company has carved out a significant position with respect to environmental management and protection; GOI4 - The company’s top managers, middle managers, and employees feel that the company have formulated well-defined environmental goals and missions; GOI5 - The company’s top managers, middle managers, and employees are knowledgeable about the company’s environmental tradition and culture;

Construct	Items
	GOI6 - The company's top managers, middle managers, and employees identify that the company highly pay attention to environmental management and protection; *GOI7 - Senior and middle managers and employees share the company's environmental programs and activities on personal social media*.
Individual green values - IGV Islam et al. (2020); Steg et al. (2005)	IGV1 - I feel a personal obligation to do whatever I can to prevent environmental degradation; IGV2 - I feel normally obliged to save environment from degradation, regardless of what others do; IGV3 - I feel guilty when I contribute in environmental degradation; IGV4 - I feel normally obliged to protect environment instead of degradation; IGV5 - People like me should do whatever they can to protect environment from degradation; IGV6 - I would prefer to buy eco-friendly appliances.
Green behavior - GB Kim et al. (2016); Sarkis et al. (2013)	GB1 - At work, I try to learn more about the environment; GB2 - At work, I find ways of working that are better for the environment; GB3 - At work, I offer ideas for reducing our impact on the environment; GB4 - At work, I share my knowledge about the environment with others; GB5 - At work, I apply new ideas for reducing our impact on the environment; GB6 - At work, I help create green processes and products; GB7 - At work, I perform environ-mental tasks that are not required by my company; GB8 - At work, I question practices that are likely to hurt the environment; GB9 - At work, I recycle and reuse materials; GB10 - At work, I try to reduce my energy use; GB11 - At work, I encourage others to think about the environment; GB12 - At work, I help others solve environmental problems.

Note: The italic format indicator is as suggested by experts in in-depth interviews

Source: Authors

5. Conclusion and Research orientation

The study's goal is to develop a theoretical model of the direct and indirect effects of GRHM on GB, using GOI as a mediator and IGV as a moderator. Based on background theory, inheriting prior empirical investigations, and conducting in-depth interviews with experts, the author has created a research model, provided research hypotheses, and proposed a measuring scale for the variables in the model.

The authors will conduct a survey of employees at F&B firms in Ho Chi Minh City using the scale they established. The non-probability sampling approach is used for convenience, with a total of 300 samples predicted. Businesses that are anticipated to be surveyed include Heineken, Sabeco, Pizza Hut, Masan, ABI, Pizza 4P's, and more. Results The survey findings will be used to examine the relationships between variables in the study model through the PLS-SEM estimation method.

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Research on Factors Affecting the Behavior of Choosing Green Tourism in Ho Chi Minh City

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Abstract

The aim of this research is to investigate the factors influencing the choice of green tourism among tourists in Ho Chi Minh City. A questionnaire based on a five-point Likert scale was used, and a purposive sampling method was employed to collect data. A total of 286 respondents were selected. The study identified four factors affecting the green tourism choice behavior of tourists in Ho Chi Minh City: (1) Personal Attention; (2) Tourist Loyalty and Commitment; (3) Family Choice; (4) The Need to Learn About Novelty. Among these, Tourist Loyalty and Commitment has the most significant impact, with a standardized Beta coefficient of 0.392. Based on the research findings, the author proposes several solutions to enhance tourist behavior and contribute to the sustainable development of green tourism in Ho Chi Minh City in the current period.

Keywords: *Choice behavior, green tourism, Ho Chi Minh City*, *tourists*

1. Introduction

Tourists' choice of green destination is crucial for the growth and sustainability of the tourism industry, as well as environmental protection and raising public awareness of nature conservation. By prioritizing green destinations, tourists promote businesses and accommodation establishments to adopt eco-friendly practices, thereby driving the need to develop green tourism services. Traveler behavior can put positive pressure on tourism providers, encouraging them to implement more sustainable practices, which in turn helps the development of destinations and leads to changes in green tourism policies and regulations.

In the past, tourism mainly focused on visiting historical and cultural sites and exploring new areas to experience different cultures and cuisines. However, climate change and environmental pollution are becoming increasingly complex, making it necessary to change the purpose of tourism (Zhou et al., 2019). The interest in eco-friendly tourism is now more urgent than ever (Wang, 2015). Tourism trends are gradually adjusting to meet environmental protection requirements, while also benefiting the health of tourists (Gössling et al., 2012). Green tourism is emerging as a solution to the desire for responsible tourism and environmental protection. Extreme weather events, such as hurricanes and floods due to climate change, have disrupted tourism, causing travelers to prioritize destinations with preserved nature and a clean environment (Moore, 2010). Many tourists are willing to pay more for eco-friendly accommodation and services (Chia-Jung & Pei-Chun, 2014). Doods & Joppe (2001) defines green tourism through four main aspects: (i) Environmental responsibility – protecting and enhancing the natural environment to ensure sustainability; (ii) Local economic development – supporting local communities and businesses; (iii) Biodiversity – respect and preservation of indigenous cultural values; (iv) Enriching the tourism experience – encouraging participation in nature and interaction with local residents. According to Font & Tribe (2001) linking green tourism to unpolluted, pristine areas such as rivers, parks, forests, and green spaces, this form of tourism is growing rapidly worldwide due to environmental benefits, conservation of local biodiversity and culture, and health advantages. Green tourism is becoming increasingly popular in today's tourism market, with a focus on protecting the environment and conserving natural resources and local culture. This form of tourism encourages visitors to minimize their negative impact on the environment, use sustainable transportation, and choose eco-friendly services, such as eco-accommodation, local food, and sustainable tourism practices.

Ho Chi Minh City is one of the largest cities in Vietnam. According to statistics in 2023, the city has more than 8.9 million people and a total area of 2,061 km², with an average population density of about 4,292 people/km², with a population growth rate of about 2.93% per year. The rapid urbanization rate and the strong development of economic sectors make Ho Chi Minh City face higher levels of exposure and climate risk factors than other localities. Recently, the city has seen complex climate changes, including rising temperatures, rising tides, and far-reaching impacts. In addition, soil, water, exhaust and air pollution is also serious, with lead concentrations in some areas increasing by 1.25 times above the average. Also in 2023, Ho Chi Minh City welcomed more than 40 million visitors, including 5 million international visitors and 35 million domestic visitors. The pressure of a population of nearly 10 million people, along with its position as a major tourist center of the country, creates a great challenge to protect the ecological environment. Currently, green tourism is becoming one of the city's sustainable development strategies, with the goal of creating a positive tourism experience while maintaining a balance with nature and the local community. The popularity of green tourism requires tourism industry stakeholders to understand travelers' perceptions of this form, capture the factors that influence their behavior, and adjust their intention to choose a destination. However, travel behavior is constantly changing, creating a major challenge for tourism managers. Currently, there is not much research on the behavior of tourists choosing green tourism in Ho Chi Minh City. This study was conducted to identify and measure the factors of tourism behavior that affect the choice of green tourism in the city. The research questions will focus on three main issues:

1. What factors of "tourism behavior" can affect the choice of "green tourism" in Ho Chi Minh City?
2. What is the impact of tourism behavioral factors on green tourism in Ho Chi Minh City?
3. What management implications should be proposed in accordance with the research results to improve tourist behavior to contribute to the sustainable development of green tourism of Ho Chi Minh City in the current period?

2. Literature review

2.1. Tourist behavior

Solomon (1996) defines consumer behavior as activities related to decisions, ideas, or experiences to meet the needs and desires of customers. Engel, Blackwell & Miniard (1995) extend this definition by specifying that consumer behavior includes all activities related to the collection, consumption and processing of services and products.

Crompton, Rothfield, and Wahab (1976) were the first to develop a model of travel behavior, which described tourists as rational decision-makers who always try to optimize the benefits of purchasing a travel product or service. However, many tourists do not have sufficient information about the destination when making a decision (Schomoll, 1977). Therefore, building brand awareness is crucial, as tourists can overlook the attractive destination if there is a lack of information and trust.

Tourism consumption behaviors are behaviors related to the process of tourism consumption, it is manifested in the search, purchase, use and evaluation of tourism products and services to satisfy certain needs of tourists (Correia & Pimpao, 2008). The nature of consumer behavior is a complex process because it comes from internal psychological factors. The study of travelers' consumer behavior is the study of how consumers make decisions to use their available resources such as money, time, and consumption of goods and services in order to satisfy their individual needs (Kotler, 2000). The traveler's consumption decision-making process is a complex sequence of decisions such as destination selection, places to visit, time to travel, membership involved, time and cost. In particular, the choice of destination is one of the important decisions of the trip and is chosen by researchers based on geographical location to visit and travel (Byon et al., 2010).

2.2. Empirical studies on factors influencing tourists' decision to choose green tourism

According to Swarbrooke and Horner (2007), traveler behavior is determined by intrinsic factors (destination knowledge and travel products; attitudes and perceptions; experiences of past trips; family and work conditions; their preferences and lifestyles) and is influenced by external factors (friends and relatives; travel marketing) calendar). Destination selection research can be seen as an important part of the study of tourism. The destination decision-making process is complicated, especially when tourists can evaluate and choose whether many of those destinations are green destinations, and whether they make sense in protecting the environment. Um and Crompton (1990), Ankomah et al. (1996), Sirakaya and Woodside (2005) explain that in order to select a destination, tourists follow a funnel-shaped procedure, starting from a relatively large initial set of alternative destinations and through a process of many stages that gradually shrink. In the end, tourists choose the most promising destination. According to the time series, from the initial theoretical study of the tourist destination selection process by Um and Crompton (1990), there have been many studies exploring the factors in the tourist destination selection model. Mayo and Jarvis (1981) explain that a customer's choice of green tourism depends on their goals and desires, as well as information from family and community. Mathieson and Wall (1982) describe the travel decision-making process as a series of time, starting with the desire to travel, seeking and evaluating information, and finally decision-making. This process continues as guests prepare for the trip, experience the product or service, and evaluate the trip upon returning home. Crompton, Rothfield & Wahab (1976) studied the pattern of personal motivation of travelers, including personal needs, desires and expectations in choosing a travel destination.

According to Moutinho (1993), "the main factors influencing consumer behavior in tourism are social influences and tourism psychology". Dimanche & Havitz (1995) identified four main factors influencing travel behavior: (i) personal interests; (ii) the loyalty and commitment of tourists; (iii) family interests; and (iv) the desire to explore new experiences. Cheng et al. (2018) classified the factors influencing the choice of green tourism into two categories: internal and external factors. The author emphasizes that internal factors, such as self-awareness, attitude, and motivation, indirectly impact green tourism behavior through behavioral intent. External factors, including the availability of green tourism services in destinations, eco-friendly accommodation, and sustainable tourism programs offered by agencies, have a direct influence on travelers' decision to choose green tourism (Hunecke et al., 2001). The decision to participate in green tourism is driven by a combination of environmental motivation and attitude, along with tourists' understanding and awareness of environmental issues and behavior formation (Cheng et al., 2018). However, the majority of behavioral theory research tends to focus on internal factors, such as personal attitudes and self-efficacy, that influence decision-making (Hunecke et al., 2001). The demand for green tourism by domestic tourists is increasing, driven by external factors such as increasing environmental pollution, increasing awareness of environmental protection, and the adverse health effects of pollution. Therefore, domestic tourists are paying more attention to eco-friendly tourism products. These products are made from eco-friendly materials, offering safe solutions for both the environment and consumer health, and minimizing the environmental impact during use.

3. Methods

3.1. Data collection

This study uses a purposeful sampling method to survey tourists' behavior towards green tourism in Ho Chi Minh City. Only tourists who are actively participating in green tourism activities are selected as models. Aspects of travel behavior are expressed through different factors, and the level of agreement with each factor will be evaluated on a 5-point scale, ranging from 1 - completely disagree to 5 - completely agree.

After completing the questionnaire, it was sent to 10 scholars and 10 experts in the tourism industry to check the content. The selected professionals have their knowledge of the tourism industry, especially in the fields of green tourism. Based on their responses, the questionnaire was edited to fix spelling errors, language issues, and revise various questions. After the questionnaire was completed, it was sent to 300 guests to investigate the impact of tourists' green tourism choices in Ho Chi Minh City. The survey period is from May to July 2024. After removing and cleaning up the invalid votes, the number of votes collected was 286. The collected information will be processed by SPSS software and data analysis: descriptive statistical techniques, Cronbach's Alpha analysis, exploratory factor analysis (EFA) and regression analysis.

3.2. Research model

Based on related theories, the authors propose a research model consisting of four main factors influencing travel behavior: (1) personal interests; (2) the loyalty and commitment of tourists; (3) family interests; and (4) Desire to explore new experiences.

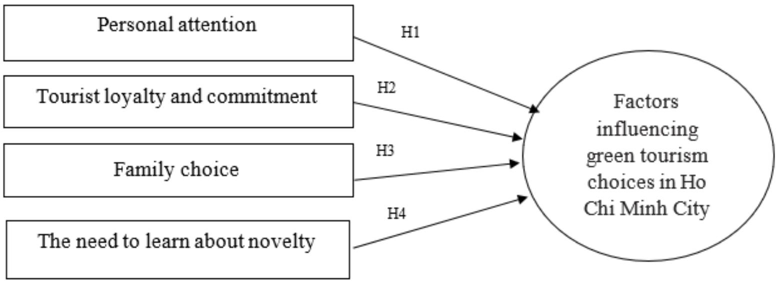

Figure 1: Research model

Source: Author

Research hypotheses:

H1: " Personal attention has a positive influence on tourists' choice of green tourism in Ho Chi Minh City”
H2: " Tourist loyalty and commitment have a positive influence on tourists' choice of green tourism in Ho Chi Minh City".
H3: " Family choice has a positive influence on the choice of green tourism of tourists in Ho Chi Minh City".
H4: " The need to learn about novelty has a positive influence on the choice of green tourism of tourists in Ho Chi Minh City

The scale of the observed variable, shown in detail in Table 1.

Table 1: Scale table of observed variables

No.	Ampersand	Observation variables
1	*Personal attention (PA)*	
1.1	PA1	I regularly zlearn about the impact of tourism on the environment
1.2	PA2	I prioritize choosing travel services that are committed to protecting the environment
1.3	PA3	I feel personally responsible for minimizing the environmental impact of travel
1.4	PA4	I often choose travel destinations that are more environmentally friendly.
1.5	PA5	I am willing to pay more for green and sustainable tourism services
1.6	PA6	I believe that my choice in travel can contribute to protecting the global environment.
2	*Tourist loyalty and commitment (TC)*	
2.1	TC1	I often choose travel and service companies that are committed to protecting the environment.
2.2	TC2	I believe that choosing green travel can contribute to making a positive difference to the environment
2.3	TC3	I am willing to encourage friends and relatives to choose green travel if they intend to travel.
2.4	TC4	I often prioritize destinations and travel activities that are certified as green and sustainable.
3	*Family choice (FC)*	
3.1	FC1	My family members often encourage me to choose green travel activities when coming to Ho Chi Minh City."

No.	Ampersand	Observation variables
3.2	FC2	My family's travel decisions are often influenced by factors related to environmental protection and sustainability
3.3	FC3	My family is interested in choosing green travel options for the overall benefit of the community and the environment.
3.4	FC4	When choosing green travel options, the consensus of all family members is an important factor
4	*The need to learn about novelty (LN)*	
4.1	LN1	I like to explore new and previously unknown travel destinations.
4.2	LN2	I often look for travel activities that are unique and different from traditional experiences
4.3	LN3	I appreciate green travel destinations that provide unique and different experiences compared to traditional destinations.
4.4	LN4	I tend to choose green travel trips if they provide the opportunity to explore new and different things.

Source: Author

4. Results

4.1. Reliability testing of scales

Table 2 shows: "The Cronbach's Alpha coefficient of the groups from 0.814 to 0.975 is > 0.5, so in terms of the reliability of the scales to ensure the requirements; The total variable correlation coefficient ranges from 0.866 to 0.934 > 0.3, so there is a correlation between the variables. In conclusion, the variables meet the conditions for further implementation in exploratory factor analysis (EFA)."

Table 2: Testing the reliability of independent variables

Scale	Coefficient Cronbach's Alpha	Correlation coefficient Sum variables
1. Personal attention (PA)	0.929	0.907
2. Tourist loyalty and commitment (TC)	0.975	0.934
3. Family choice (FC)	0.890	0.902
4. The need to learn about novelty (LN)	0.814	0.866
5. The behavior of choosing green tourism ends	0.960	

Source: Extracted from SPSS

4.2. EFA analysis

4.2.1. EFA analysis with independent variables

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.760**
Bartlett's Test of Sphericity	Approx. Chi-Square	1759.655
	df	153
	Sig.	**.000**

Source: Extracted from SPSS

Table 4: Rotation matrix of independent factors

Variables	Factor Load Factor			
	1	2	3	4
PA1	.888			
PA2	.884			
PA3	.881			
PA4	.874			
PA5	.800			
PA6	.624			
TC1		.925		

Variables	**Factor Load Factor**			
	1	**2**	**3**	**4**
TC2		.921		
TC3		.908		
TC4		.900		
FC1			.910	
FC2			.907	
FC3			.771	
FC4			.617	
LN1				.793
LN2				.787
LN3				.703
LN4				.696

Source: Extracted from SPSS

Table 3 shows: "KMO coefficient = 0.760 > 0.5 of independent variables, so this EFA analysis is appropriate. And testing Barlett with Sig. = 0.000 significance; In terms of linear correlation, the observed variables from PR1 to ML3 have a high correlation with independent factors. From the results of the matrix analysis, the observed variables have a load coefficient of > 0.5 and are arranged in order, so the model will not have any kind of bad variables."

4.2.2. EFA analysis with correlation analysis

Table 4: EFA results for dependent variables

Observation variables	**Factor Load Factor**
	1
F1	0.964
F2	0.948
F3	0.946
F4	0.923

Source: Extracted from SPSS

The EFA results show that the KMO coefficient = 0.847 > 0.5 and Bartlet has a Sig. = 0.000 result. Along with that, the scales all have a factor load factor value of > 0.5, so all 4 variables meet the requirements for convergence and reliability values (Table 4).

4.3. Compatibility analysis

Table 5 shows: "The correlation coefficient between independent and dependent variables has a high degree of correlation, specifically ranging from 0.196 to 0.780. Inferred, the drug subvariable will be explained by independent variables. Besides, independent variables all have a value of Sig. > 0.05, so the hypothesis should be accepted. And the overall correlation coefficient is 0, so there is no variance of variation in the model. At the same time, the VIF coefficients of independent variables < 2, so no multi-collinear phenomenon occurs (Table 6)".

Table 5: Correlation matrix between independent and dependent variables

Correlations						
		PA	TC	FC	LN	F
PA	Pearson Correlation	1	.328**	.196**	.452**	.667**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	286	286	286	286	286
TC	Pearson Correlation	.328**	1	.520**	.319**	.780**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	286	286	286	286	286
FC	Pearson Correlation	.196**	.520**	1	.453**	.756**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	286	286	286	286	286
LN	Pearson Correlation	.452**	.319**	.453**	1	.706**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	286	286	286	286	286
F	Pearson Correlation	.667**	.780**	.756**	.706**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	286	286	286	286	286

*Note: Symbol **: Indicates that this pair of variables has a linear correlation with a confidence level of 99% (corresponding to a significance level of 1% = 0.01).*

Source: Extracted from SPSS

4.4. Multiples regression analysis

Table 6 shows: "Adjusted R^2 = 0.997, equivalent to 99.7% of the direct impact on the microbehavior of choosing green tourism of visitors in Ho Chi Minh City is determined by the following factors: (1) Personal attention; (2) Tourist loyalty and commitment; (3) Family choice; (4) The need to learn about novelty. In addition, check that F has a very small Sig value (Sig. = 0.000), choose a research model with a suitable survey sample. The dependent variable F and the independent variables PR, IF, TI, AT, CN, ES, ML are all statistically significant because Sig < 0.05. The variance magnification factor is quite high (Tolerance from 0.629 to 0.747) and the VIF factor <. 2 (from 1,339 to 1,590), so there is no maximum collinearity between the independent variables. A summary of the results of the recovery model is as follows: ***Y= 0,005 + 0,392*TC + 0,367*FC +0,350*PA + 0,256LN***

Table 6: Results of regression analysis

Model		Unstandardized regression coefficients		Normalized regression coefficients	t	Sig. Acceptance	Multiline Statistics	
		B	Standard Error	Beta			Variance magnification factor	VIF
1	Constant	0,005	0,012		0,412	0,674		
	PA	0,262	0,003	0,350	100,291	0,000	0,747	1,339
	TC	0,255	0,002	0,392	106,709	0,000	0,677	1,478
	FC	0,241	0,002	0,367	96,451	0,000	0,629	1,590
	LN	0,244	0,004	0,256	68,817	0,000	0,658	1,520
R^2 calibration: 0.997 Durbin-Watson Statistics: 2,536 Statistics F(ANOVA): 27352,781 Significance Level (Sig. of ANOVA): 0.000								

Source: Extracted from SPSS

5. Conclusion and Recommendations

5.1. Conclusion

From the testing results, it shows that the theoretical model is appropriate, there are 04 factors accepted, thereby showing the degree of influence of the factors on the behavior of choosing green tourism of tourists in Ho Chi City Minh is arranged in descending order of influence as follows: (1) Tourist loyalty and commitment has a standardized Beta coefficient = 0.392; (2) Family choice a standardized Beta coefficient =0.367; (3) Personal attention a standardized Beta coefficient =0.350; (4) The need to learn about novelty a standardized Beta coefficient =2.56.

5.2. Recommendations

Firstly, improving the loyalty and commitment of tourists in choosing green tourism in Ho Chi Minh City.

In order to promote the loyalty of tourists and commit to green tourism in Ho Chi Minh City. Ho Chi Minh City needs to raise public awareness through communication campaigns to introduce the benefits of green tourism to both the environment and local communities. Partnering with educational institutions and community organizations to organize workshops and workshops on sustainable tourism and environmental conservation is also important. Building a sense of community and fostering connections through online groups and events with environmental organizations can increase participation. Partnering with local businesses to provide unique experiences that can further enhance the appeal of green tourism. By adopting these strategies, we can encourage tourist loyalty, promote green tourism and support the sustainable development of the tourism industry in Ho Chi Minh City.

Secondly, improve the choice of families in finding sustainable green tourism destinations

Launch targeted communication campaigns targeting families to highlight the benefits of green tourism. Clearly state how green tourism positively impacts both families and local communities. Organize workshops and workshops specifically designed for families to explain the advantages of green tourism and provide information on eco-friendly travel options. Develop specialized green travel packages that are suitable for families, including eco-friendly activities and services that cater to both children and adults. Offer incentives and discounts for families who choose green travel, such as free packages for children or group discounts. Organize fun green tourism activities for the whole family, such as eco-tours, craft classes using recycled materials, or eco-friendly outdoor adventures. Providing opportunities for families to immerse themselves in local culture and customs, fostering a deeper connection with the community. Ensuring green tourism services not only prioritizes environmental friendliness but also upholds high standards of quality and safety for families.

Thirdly, raise personal concerns in finding sustainable green tourism destinations

Use a variety of media channels, including social media, newspapers, and television, to reach a wide variety of audiences. Introduce sustainable tourism education programs in schools, community organizations, and public events. Develop instructional materials and educational videos to clearly convey the advantages of green tourism. Create and maintain online platforms that provide comprehensive information on green tourism options in Ho Chi Minh City. Share insights into eco-friendly destinations, services, and activities. Includes guidance and reviews from past travelers to help individuals make informed choices about green tourism. Providing attractive incentives and discounts for those who choose green tourism. Set up a loyalty program to reward regular green travelers with exclusive benefits and rewards. Developing a special green tourism experience sets it apart from other travel options, which can include eco-tours, volunteering for environmental projects, or exploring conservation areas.

Fourthly, stimulate the need to learn novelties for tourists

Designing unique green tours with new activities such as visiting protected areas, participating in community projects or special ecological activities will bring unique value to visitors. Organizing creative green tourism events, such as workshops on making from recycled materials, green technology demonstrations in tourism, or environmental protection festivals are also very important. Besides, taking advantage of technology to enhance the experience is an effective direction. It is possible to develop a mobile application or online platform that provides information, guidance, and virtual reality experiences related to green tourism. The app can include maps of green destinations, reviews from users, and insights into eco-friendly practices. Using virtual reality (VR) and augmented reality (AR) technology is also a good way to provide interactive experiences, allowing users to visualize and participate in remote activities and destinations. In addition, creating engaging blog posts and videos about green tourism destinations, environmental protection activities, as well as success stories in sustainable tourism will contribute to raising awareness. Sharing this content widely on social media platforms and travel websites will help reach a wider audience. Implementing these strategies not only brings an exciting and innovative travel experience, but also raises the awareness and commitment of tourists in Ho Chi Minh City to protect the environment.

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Key Factors Influencing Tourists' Choice of River Tourism in Ho Chi Minh City, Vietnam

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Abstract

River tourism is an emerging industry in Ho Chi Minh City, and it has attracted significant investment from the local government and enterprises to develop this sector. Therefore, it is crucial to understand the factors influencing tourists' decision to choose river tourism to formulate effective strategies to attract more visitors to this tourism mode in Ho Chi Minh City. This study used primary data collected from 114 Ho Chi Minh City tourists and employed binary logistic regression for data analysis. The study's findings indicate that 57% of the sample size participated in river tourism activities in the city. Among the different modes of river tourism, the water bus was the most popular choice among tourists, while the motorboat was the least preferred option, mainly due to cost considerations. Furthermore, tourists positively agreed to seek new experiences through river tourism. The estimated regression model revealed that experience, cost, safety, and environmental factors significantly influenced tourists' decision to choose river tourism. Therefore, to further promote river tourism in Ho Chi Minh City, it is crucial to enhance tourists' experience by providing unique and memorable activities, improving the environment along the river, ensuring safety measures, and upgrading infrastructure and facilities.

Keywords: *Ho Chi Minh City, logistic regression, river tourism, tourists' decision*

1. Introduction

Ho Chi Minh City emerges as a preeminent nexus for tourism within Vietnam, drawing a substantial influx of international visitors, estimated at 477,982, and domestic visitors, amounting to 11,089,304 in the initial half of the current year. This burgeoning influx has generated tourism revenue of approximately 49,681 billion VND, an increment that denotes a robust growth trajectory from the preceding year's analogous timeframe.

River tourism has emerged as a potential growth sector in Ho Chi Minh City, leveraging the city’s extensive network of rivers and waterways to offer unique tourist experiences. Recognizing this potential, local governments and enterprises have invested heavily in infrastructure and services to promote river tourism as a key component of the city’s broader tourism strategy. Current developments include river tour routes such as Bach Dang - Cu Chi and Bach Dang - District 7 and interprovincial routes like Bach Dang - Cu Chi - Binh Duong. Moreover, The city’s government and tourism authorities have also recognized the importance of river tourism, as evidenced by plans outlined in Decision 3364/QD-UBND 2018, which details the Strategic Outline for Ho Chi Minh City Tourism Development through 2030 (People's Committee of Ho Chi Minh City, 2018). These plans focus on improving infrastructure, enhancing transportation support, developing services, and increasing public awareness of river tourism (Ministry of Culture Sports and Tourism, 2023). However, despite these efforts, there remains a limited understanding of the factors influencing tourists' decisions to engage in river-based activities. Without a clear grasp of these determinants, initiatives to increase river tourism participation may be misdirected or ineffective.

River tourism has long been a research topic of many studies on a global scale (van Balen et al., 2014; Fachrudin & Lubis, 2016; Chen et al., 2018; Zhang et al., 2020; Abbas et al., 2021). In Brussels, van Balen et al. (2014) explored the economic impacts of river tourism on the port region in terms of added value, employment, port revenues, and fiscal impact. The study utilized a scenario planning methodology to assess different scenarios and determine the optimal level of investment in river tourism infrastructure. In

Taiwan, the Love River in Kaohsiung City underwent urban riverbank reconstruction to enhance its attractiveness for tourism. The government's efforts also included the construction of relevant facilities and regulation of the river's scenery and space (Chen et al., 2018). Abbas et al. (2021) examined the characteristics and attractions of river tourism in Banjarmasin, highlighting its significance in promoting tourism development. In China, Zhang et al. (2020) examined the spatial pattern and influencing factors of tourism development in the Yellow River Basin. The study analyzed the distribution and characteristics of tourist destinations in the region and identified the key factors contributing to tourism development.

In Vietnam, studies on river tourism have also been conducted but are limited in number. Hien and Hiep (2016) explored the potential of event-based river tourism product diversification in Bien Hoa City, Dong Nai Province, Vietnam. Drawing lessons from South Korea, the study suggested strategies for developing diverse and engaging river tourism products that capitalize on local cultural events and festivals. Dang (2021) highlighted the importance of balancing economic growth with environmental conservation and community involvement in achieving sustainable tourism development in Vietnam's Red River Delta. Nguyen (2021) investigated the importance of push and pull factors in understanding tourist satisfaction and behavioral intention toward river tourism in Can Tho City.

While river tourism offers unique experiences and opportunities for tourists and local economies, the factors driving tourists' choices in this context have yet to be adequately explored. Understanding tourists' choices is crucial for effective destination marketing and planning. Eugenio-Martin (2003) proposed a five-stage model to analyse tourism demand, providing a framework for studying tourist behavior. Bowden (2006) examined international tourists' choices in China's gateway cities, highlighting the importance of cultural differences. Lee et al. (2009) focused on Taiwan's hot springs, emphasizing natural resources and cultural heritage in shaping domestic tourists' preferences. Pulina et al. (2013) revealed how residents' attitudes influence sustainable tourism management. Xiaolei (2015) studied ecotourism in nature reserves, underscoring sustainable development. Binh and Huong (2020) identified tourism motivation, destination image, trip expenses, and broadcast information as key factors for domestic tourists in Ben Tre. Pestana et al. (2020) explored motivations, emotions, and satisfaction in destination choice. Sánchez-Rivero et al. (2020) analysed inland water tourism in Spain while Phong et al. (2023) identified price, image, attractiveness, and motivation as critical for tourists in Dong Thap, Vietnam. These studies collectively highlight the complex factors influencing tourists' decision-making.

Previous studies on river tourism have explored diverse aspects, such as visitor satisfaction, destination management, economic impacts, environmental concerns, and investment priorities, providing valuable insights for various destinations. However, there is a significant gap in research focused specifically on urban river tourism, especially in rapidly developing cities like Ho Chi Minh City. Given that this type of tourism is relatively new in the region, there is an urgent need to explore the key factors influencing tourists' choices. Understanding these factors is crucial to developing strategies that not only attract more visitors but also ensure that river tourism in Ho Chi Minh City is sustainable and meets tourists' expectations.

The primary objective of this research is to identify and quantify the factors that significantly impact tourists' choices regarding river tourism in Ho Chi Minh City. By employing a binary logistic regression model, this study provides empirical evidence on the relative importance of various determinants such as experience, cost, safety, and environmental factors. Understanding these factors is essential for policymakers and tourism developers to design targeted interventions to enhance tourist satisfaction and increase participation in river tourism activities.

The novelty of this research lies in its focus on urban river tourism - a relatively underexplored area within tourism studies, particularly in the context of Southeast Asia. Unlike previous studies that focus on more established forms of tourism, this study provides valuable insights into the emerging market of river tourism, offering a detailed analysis of the factors that influence tourist behavior in this specific setting. The findings will contribute to both academic knowledge and practical policymaking, providing guidance on how to develop river tourism in a way that is economically viable, environmentally sustainable, and responsive to tourist preferences. As such, this study fills a critical gap in the literature and provides actionable recommendations for stakeholders in Ho Chi Minh City's river tourism industry.

2. Methods

2.1. Study area

Ho Chi Minh City is situated in Vietnam within the coordinates of approximately 10°10' to 10°38' N latitude and 106°22' to 106°54' E longitude, sharing its borders with several adjacent provinces. Binh Duong Province borders it to the north, Tay Ninh Province to the northwest, Dong Nai Province to the east and northeast, Ba Ria-Vung Tau Province to the southeast, and Long An and Tien Giang Provinces to the west and southwest. Renowned for its extensive river and canal system, Ho Chi Minh City features prominent waterways, including the Saigon and Dong Nai Rivers, the Nha Be River, and the Can Gio mangrove forest. The city's waterway network is further augmented by 11 major canals penetrating the urban fabric. The Dong Nai and Saigon Rivers' convergence occurs within the city's heart, flowing through the Nha Be and Soai Rap sections, which span a combined distance of 80 kilometers. The canals extend over 700 kilometers, with the canal areas encompassing roughly 835 hectares, predominantly within the southern and eastern districts. Historically, this elaborate lattice of canals was integrally linked with the river and canal system of the Mekong Delta. This connection facilitated a thriving trade network, which was instrumental in the city's development as a river-centric urban zone.

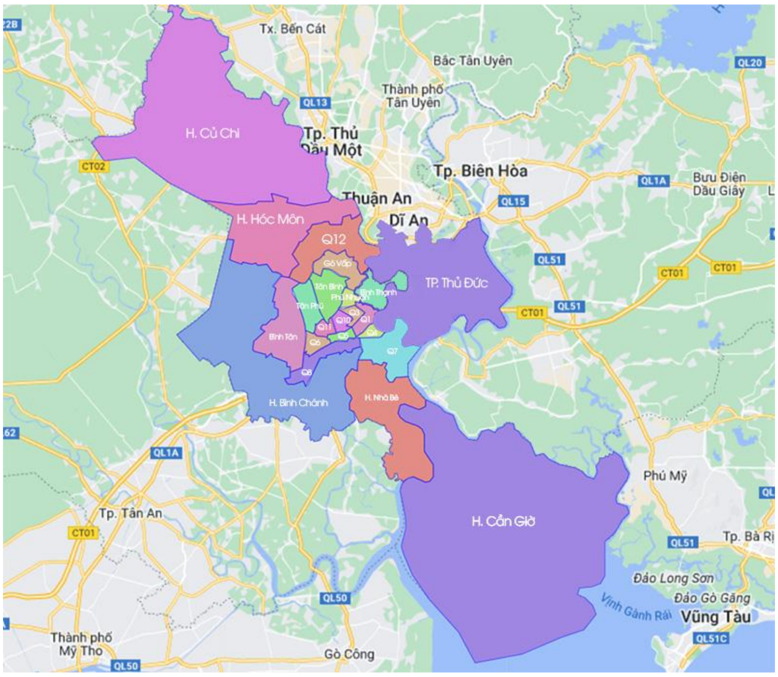

Figure 1: Study area

Source: Google map (2023)

2.2. Data collection

This study collected primary data through face-to-face interviews with tourists in Ho Chi Minh City. The sample size for the study was determined using the formula provided by Tabachnick et al. (2013), which considers the number of independent variables in the model.

$$n = 50 + 8m \quad (1)$$

where n is the sample size, and m is the number of independent variables in the model. This study employed logistic regression with eight independent variables. Therefore, the minimum sample size was 90.

The study targeted domestic and international tourists who had participated in or considered participating in river tourism in Ho Chi Minh City. A total of 114 tourists were surveyed using a convenience sampling method. While convenience sampling may introduce some biases, it was chosen due to the practical constraints of reaching a broad population of tourists over a relatively short data collection period. Participants were approached at popular Ho Chi Minh City tourist locations, including river docks, hotels, and major tourist attractions. The sample included tourists of different ages, nationalities, and travel backgrounds to ensure a more diverse and representative dataset.

A structural questionnaire was designed to ensure comprehensive data collection for the study. The questionnaire contains two sections. The first section focused on gathering general information from the participants, such as their gender, age, education, and income. The second section explored specific information about Ho Chi Minh City river tourism, including tourists' experiences, awareness, concerns, and expectations.

While this study provides valuable insights, several limitations regarding the dataset must be acknowledged. First, the convenience sampling method may limit the generalizability of the findings, as it only partially captures the diversity of all tourists visiting Ho Chi Minh City. Additionally, the sample size (n=114) is relatively small, which may reduce the statistical power of the analysis. Future studies should aim to use a larger, more random sample to ensure broader applicability of the results.

2.3. Method

This study employed a binary logistic regression model to examine the factors influencing tourists' decision to participate in Ho Chi Minh City river tourism. Logistic regression was selected because the dependent variable—whether a tourist chose to participate in river tourism—is binary in nature (1 for "yes," 0 for "no"). The choice of this model is justified by its ability to estimate the probability of a binary outcome based on one or more predictor variables.

The key independent variables selected for the model are based on a review of the relevant literature on tourism behavior. These variables were chosen for their theoretical significance and relevance to the specific context of river tourism. Each variable is defined and discussed systematically below:

Experience: This variable represents tourists' desire to seek unique and memorable experiences through river tourism. Previous studies have shown that tourists are often motivated by the opportunity to engage in novel activities and gain new experiences, particularly in urban environments. The allure of river tourism can be further magnified by special events and activities that pique interest and offer novel experiences (Chen et al., 2018). This study measured experience by tourists' self-reported interest in exploring river-based activities and their past experiences with river tourism.

Hypothesis H1: Tourists with a higher preference for unique experiences are more likely to choose river tourism.

Cost*:* Cost refers to tourists' perceptions of the affordability of river tourism compared to other forms of tourism available in the city. Cost is a fundamental consideration that can directly influence consumer decision-making. Nguyen (2021) highlighted that tourists deliberate over the financial implications of tourism activities, balancing the cost of services against anticipated benefits and experiences. A perceived equitable cost-quality ratio can encourage tourists to participate in river tourism, while disproportionate costs may deter them. To measure this, respondents were asked to evaluate the pricing of river tourism services relative to their expectations and budgets.

Hypothesis H2: *Tourists who perceive river tourism as affordable or offering good value for money are more likely to participate.*

Safety (SAFE)*:* Safety is a critical factor influencing tourists' participation in any form of tourism, particularly in activities involving physical risks, such as river boating or water-based activities (Nguyen Hoang et al., 2021). This variable captures tourists' perceptions of the safety measures implemented during river tourism, such as the availability of life vests, trained guides, and the reliability of boats. The perceived inadequacy of these measures may negatively affect their willingness to participate in river tourism, whereas robust safety protocols can bolster their confidence and propensity to engage.

Hypothesis H3: Tourists with a positive perception of safety are more likely to choose river tourism.

Environmental evaluation (ENV)*:* Environmental factors refer to tourists' perceptions of the quality of the riverine environment, including cleanliness, the aesthetic appeal of the surroundings, and ecological conditions. The environmental evaluation is crucial in the context of river tourism, as tourists often seek visually appealing and ecologically healthy environments. Nguyen Hoang et al. (2021) underscored the importance of tourists' perceptions of the water environment when selecting tourism activities. Perceptions of pollution or the absence of compelling landscapes may dissuade engagement in river tourism (Nguyen, 2021). This study measured environmental factors by asking participants to rate their satisfaction with the river's cleanliness, the riverbanks' condition, and the overall environmental quality.

Hypothesis H4: Tourists with a positive evaluation of the river environment are more likely to choose river tourism.

Demographic variables: In addition to the primary variables, demographic factors such as age, gender, education, and income were included in the model as control variables. Demographic characteristics can influence decision-making in various ways. For instance, younger tourists might prioritize different factors, such as cost or adventure, compared to older tourists, who may emphasize safety and comfort more.

Tourists with higher disposable income levels demonstrate a propensity for selecting river tourism, facilitated by their greater economic capacity to allocate resources towards enhanced travel experiences. Zhang et al. (2020) identified a positive correlation between income levels and the preference for river tourism within the Yellow River Basin, suggesting that affluence significantly determines tourist behavior in this context. Additionally, spatial discrepancies in tourism income are more pronounced than in tourist numbers, indicating that economic factors are integral to the decision-making process for engaging in river tourism. The financially affluent are more inclined to avail themselves of river tourism offerings, presumably due to their capacity to afford such experiences.

Gender dynamics also play a role in tourism preferences, with the hypothesis that female tourists exhibit a predilection towards cultural tourism, potentially owing to a heightened receptiveness to educational and cultural enrichment. This study anticipates that female tourists will demonstrate a stronger inclination to engage in cultural forms of tourism.

Educational attainment is often associated with an increased interest in cultural enrichment and the pursuit of knowledge (McManus & Furnham, 2006). Given that river tourism frequently presents opportunities for cultural engagement, historical exploration, and educational enrichment, it stands to reason that individuals with advanced educational backgrounds may exhibit a greater likelihood to opt for river tourism.

Hypothesis H5: Tourists with a higher disposable income are more likely to choose river tourism.

Hypothesis H6: Female tourists are more likely to choose river tourism.

Hypothesis H7: Tourists with higher education are more likely to choose river tourism.

Hypothesis H8: Younger tourists are more likely to choose river tourism.

The logistic function is presented as follows:

$$P = \frac{e^z}{1+e^z} \tag{2}$$

Wherein: $Z = B_i X_i \ (B \ and \ X \ are \ vectors)$

$$\Pr(P_i = 1|X_i, \beta_i) = p_i = \frac{\exp(\beta_o+\beta_1 X_1+\cdots+\beta_k X_k)}{1+\exp(\beta_o+\beta_1 X_1+\cdots+\beta_k X_k)} \tag{3}$$

Wherein P_i is the probability of tourist$_i$'s decision toward river tourism in Ho Chi Minh City (P = 1 signifies choosing river tourism, P = 0 indicates otherwise); β_i are coefficients.

The marginal effects of X_i on P were calculated by taking the partial derivative of P with respect to X_i. After linearization, equation (3) becomes:

$$1 - P_i = 1 - \frac{e^{\beta_o+\beta_1 X_1+\cdots+\beta_k X_k}}{1+e^{\beta_o+\beta_1 X_1+\cdots+\beta_k X_k}} \leftrightarrow \frac{P_i}{1-P_i} = e^{\beta_o+\beta_1 X_1+\cdots+\beta_k X_k} \tag{4}$$

Let $L_0 = \frac{P_i}{1-P_i}$ be the initial probability of tourists' decision to choose river tourism. When other factors remain constant, if Xi increases by one unit, the new probability of accepting river tourism is given by:

$$L_1 = \frac{P_1}{1-P_1} = L_0 * e^{\beta_k} \; or \; P_1 = \frac{L_0 * e^{\beta_k}}{1+L_0 * e^{\beta_k}} \quad (5)$$

The independent variables of the binary logistic regression are presented in *Table 1*.

Table 1: Independent variables of the binary logistic regression

Variables	Explanations	Unit of measurement	Expected signs	References
INC	Disposable Income	Mil. VND/month	(+)	(Zhang et al., 2020)
GD	Gender	Female = 0 Male = 1	(-)	
EDU	Education	1. Primary school 2. Secondary school 3. Highschool 4. Undergraduate 5. Graduate	(+)	(McManus & Furnham, 2006)
AGE	Age	Years	(-)	
ENV	Environmental evaluation	1. Very polluted 2. Polluted 3. Normal 4. Clean 5. Very clean	(+)	(Nguyen Hoang et al., 2021; Nguyen, 2021)
SAFE	Safety concerns	1. Do not care 2. Care a little 3. Neutral 4. Care much 5. Care very much	(+)	(Nguyen Hoang et al., 2021)
EXPERIENCE	New experience from river tourism	1.Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree	(+)	(Chen et al., 2018)
COST	Cost perception	1. Cheap 2. Normal 3. Expensive	(-)	(Nguyen, 2021)

Source: Author's compilation

3. Results and Discussion

3.1. Description of the sample size

Table 2 delineates the demographic composition of the survey participants, offering a balanced gender representation among the 114 individuals: 55 males (48.25%) and 59 females (51.75%). This equilibrium suggests the collection of a broad spectrum of gender-related insights. The predominant age demographic, 20 to 40 years, encompasses 88 respondents (77.19%), indicating that most participants are in their active economic years. Those aged 41 to 60 years and under 20 years are represented by 20 (17.54%) and five individuals (4.39%), respectively, with the senior demographic above 60 years constituting a minimal segment of one respondent (0.88%). Regarding educational attainment, the sample predominantly consists of individuals with undergraduate degrees, 89 in total (78.1%), reflecting a sample with a substantial educational foundation. High school graduates are represented by 16 individuals (14%), and postgraduate degree holders by nine (7.9%), presenting a gradient of educational backgrounds. The survey captures a wide array of occupational backgrounds. Office workers comprise the largest cohort, with 50 respondents (43.86%) and 38 students (33.33%). Entrepreneurs are also present in the sample, totaling seven respondents (6.14%). Fewer participants are identified as farmers, retirees, or other occupations, showcasing the sample's occupational diversity.

Residential demographics reveal that the vast majority of respondents, 105 individuals (92.11%), are Vietnamese residents, with a minority of nine respondents (7.89%) being foreigners, suggesting a predominantly local perspective with some international input.

Table 2: Characteristics of the surveyed tourists

Characteristics	Count	Ratio (%)
	N = 114	
Gender		
Male	55	48.25
Female	59	51.75
Age		
Belove 20	5	4.39
20 to 40	88	77.19
41 to 60	20	17.54
Above 60	1	0.88
Education		
High school	16	14
Undergraduate	89	78.1
Graduate	9	7.9
Occupation		
Worker	9	7.89
Farmer	1	0.88
Student	38	33.33
Office worker	50	43.86
Entrepreneurship	7	6.14
Retirement	3	2.63
Others	8	7.03
Residence		
Foreign	9	7.89
Vietnamese	105	92.11

Source: Author's calculation

Most participants (57%) have experienced river tourism, reflecting substantial interest and activity in this sector. Conversely, a significant minority (42.98%) have not yet participated in river tourism, suggesting untapped potential for market expansion within this demographic. This data underscores the opportunity for further development in the river tourism industry, targeting those who have yet to engage in these activities.

Within the sample size, 50 (43.86%) have utilized boats or yachts for sightseeing, signifying a notable preference for this type of riverine transportation among the participants. The water bus emerges as the most favored mode of river transport, with 55 individuals (48.25%) selecting it. Its popularity is attributed to its affordability, with fares commencing at 15,000 VND per journey, positioning it as an accessible option for tourists wishing to experience river vistas without incurring significant expense. Conversely, motorboats are the least favored, with only 14 individuals (12.28%) opting for this mode of transport. The higher rental costs associated with motorboats may be prohibitive for some tourists. These findings illuminate tourist transportation preferences in river tourism, emphasizing the water bus's prominence due to its cost-effectiveness.

3.2. Tourists' awareness of river tourism in Ho Chi Minh City

Most respondents prioritize safety during river cruises, with 75.54% expressing concern. Expressly, 35.08% of tourists indicated high concerns ("care very much"). These figures underscore the critical need for robust safety measures on river cruises to reassure and protect tourists. Opinions about the water quality of the Saigon River are mixed. The largest group, 49.12%, remains neutral, suggesting ambivalence or lack of strong opinion on the river's condition. Besides, 39.48% perceive some level of pollution ("polluted" and "very polluted" combined), pointing to the necessity for environmental enhancement initiatives to bolster the appeal of river tourism. Most tourists view the prices for river tourism as reasonable, with 74.07% labeling them as "normal." Meanwhile, a smaller proportion consider the prices favorable ("cheap" at 15.74%) or unfavorable ("expensive" at 10.19%). This price perception distribution indicates the importance of balanced pricing strategies that cater to varied economic expectations among tourists, which is crucial for the sector's sustainability and growth.

Table 3: Tourists' awareness of river tourism in Ho Chi Minh City

	Count	Ratio (%)
	N = 114	
Safety concerns		
Do not care	0	0
Care a little	7	6.14
Neutral	30	26.32
Care much	37	32.46
Care very much	40	35.08
Environment		
Very polluted	8	7.02
Polluted	37	32.46
Neutral	56	49.12
Clean	11	9.65
Very clean	2	1.75
Price perception		
Cheap	17	15.74
Normal	80	74.07
Expensive	11	10.19

Source: Author's calculation

The data indicates that a substantial portion of respondents appreciates the aesthetic qualities of the riverside (**Error! Reference source not found.**), with 69.30% expressing agreement or strong agreement regarding the scenery's cleanliness and beauty. This suggests that the visual appeal of the riverside is a valued aspect of the river tourism experience. Night-time views of the city from the Saigon River also receive high praise, with 68.42% of respondents acknowledging this as an enjoyable and noteworthy experience. The low levels of disagreement on this aspect highlight the popularity of this activity among those surveyed. The perception of air quality is similarly positive, with 70.18% of respondents agreeing or strongly agreeing that the riverside air is fresh and cool, indicative of a favorable environmental experience. Finally, the absence of traffic congestion and dust is recognized by 71.93% of respondents, who agree or strongly agree that this contributes to a more relaxing and comfortable riverside environment. The minimal disagreement suggests that traffic and cleanliness are currently minor concerns for most of those surveyed in this context.

Table 4: Experiences from river tourism

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Clean and beautiful riverside scenery	Count	1.00	12.00	22.00	60.00	19.00
	Ratio (%)	0.88	10.53	19.30	52.63	16.67
Admiring the city at night on the Saigon River	Count	1.00	6.00	29.00	58.00	20.00
	Ratio (%)	0.88	5.26	25.44	50.88	17.54
Fresh and cool air	Count	1.00	9.00	24.00	62.00	18.00
	Ratio (%)	0.88	7.89	21.05	54.39	15.79
No traffic congestion and no dust	Count	1.00	12.00	19.00	57.00	25.00
	Ratio (%)	0.88	10.53	16.67	50.00	21.93

Source: Author's calculation

3.3. Factors Influence tourists' decision to choose river tourism in Ho Chi Minh City

The regression model reveals that EXPERIENCE is a significant predictor of the decision to participate in river tourism at the 1% level. The environmental factor (ENV), the cost of the tourism experience (COST), and safety concerns (SAFE) are also significant at the 5% level. Thus, hypotheses H1, H2, H3, and H4 were confirmed.

Variables such as age (AGE), income (INC), gender (GENDER), and education (EDU) were not statistically significant. This could be attributed to the fact that this particular type of tourism was suitable for individuals of all ages and genders and offered varying price options to cater to different income levels. Consequently, these variables did not substantially influence tourists' decisions when choosing this type of tourism. Then, hypotheses H5, H6, H7, and H8 were rejected.

The significance of the model is confirmed by a Prob(LR statistic) value of 0.0000, which is less than the alpha level (α), indicating that the model significantly explains the variation in the dependent variable. The McFadden R-squared value of 0.71 denotes that approximately 71% of the variation in the choice to participate in river tourism is explained by the model, which is considered a robust fit. Furthermore, the high accuracy rate of 95.61% suggests that the model's predictions are highly consistent with observed outcomes, reinforcing the reliability of these findings in reflecting the reality of tourists' choices regarding river tourism in Ho Chi Minh City.

Table 5: Binary logistic regression estimation

Variables	Coefficients	z-stats
C	-16.94	-2.63
AGE	0.034	0.63
EXPERIENCE	2.71***	3.17
INC	0.03	0.22
EDU	-0.79	-0.78
ENV	1.78**	2.23
GENDER	-0.17	-0.14
COST	-0.01**	-2.04
SAFE	2.11**	2.83
Log likelihood	-16.341	
Prob(LR statistic)	0.0000	
McFadden R-squared	0.71	

*Note: ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively*

Source: Author's calculation

Based on the assumptions provided for the initial probabilities of choosing river tourism, which are 10%, 20%, 30%, 40%, and 50%, the marginal impact of each factor on the probability of acceptance are summarized in Table 6.

Table 6: Marginal effects

Variables	Coefficient	e^{Bk}	P_o(%)				
			10	20	30	40	50
EXPERIENCE	2.71	15.06	62.59	79.01	86.58	90.94	93.77
ENV	1.78	5.93	39.71	59.7	71.75	79.8	85.56
COST	-0.01	0.99	9.94	19.9	29.87	39.85	49.84
SAFE	2.11	8.25	47.84	67.36	77.96	84.62	89.19

Source: Author's calculation

The coefficient for EXPERIENCE (2.71) indicates that an increase in experience levels corresponds with a heightened likelihood of choosing river tourism, with the predicted probability of acceptance ranging from 62.59% to 93.77%, depending on the initial probabilities. This relationship corroborates previous research suggesting that experiential factors shape tourism behaviors, preferences, and future intentions (Pestana et al., 2020). However, what sets this study apart is its focus on river tourism in an urban setting.

Unlike traditional river tourism, which often occurs in rural or natural environments, Ho Chi Minh City's river tourism offers an experience that blends urban life with the natural environment. This adds a new dimension to experiential tourism, where urban rivers serve as a source of novelty for tourists. The finding suggests that enhancing the experiential aspects of river tourism, such as offering guided tours, cultural performances, or themed cruises, could further attract tourists seeking unique urban experiences.

Environmental factors emerged as a significant predictor of tourists' decisions, confirming the importance of environmental quality in tourism choices. ENV, with a coefficient of 1.78, shows that improvements in the river's environmental quality positively affect the probability of choosing river tourism, with accepting probabilities increasing to 39.71% if the initial probability is 10% or even 85.56% if the initial probability is 50%. This aligns with findings that highlighted the role of environmental satisfaction in promoting tourist return intentions (Nguyen, 2021). Tourists were found to be highly sensitive to the cleanliness and aesthetic appeal of the river environment. This finding highlights the need for sustainable tourism practices in Ho Chi Minh City’s river tourism sector. Tourists are increasingly drawn to destinations prioritizing environmental preservation and offering a clean, appealing natural setting. Tourists expect a high level of environmental quality, even in an urban setting, and are willing to forego river tourism if these expectations are unmet. This underscores the importance of integrating environmental management with tourism development in Ho Chi Minh City. Therefore, improving the river's environmental conditions, such as reducing pollution, enhancing green spaces, and maintaining clean riverbanks, could substantially increase the attractiveness of river tourism.

The COST variable's coefficient (-0.01) suggests a slight inverse relationship between cost and the probability of choosing river tourism, indicating that higher costs may deter participation. The predicted probability decreases as costs increase, echoing findings from Can (2013) regarding travel costs’ influences on tourist choices. The study reveals that tourists perceive river tourism as relatively affordable, but some activities, such as motorboat tours, are considered too expensive compared to other options like the water bus. This insight is valuable for tourism operators and policymakers who aim to make river tourism more accessible. Pricing strategies should be reconsidered to encourage broader participation, especially among budget-conscious tourists. Offering bundled packages, discounts, or promotions may help attract more tourists to this form of tourism.

Lastly, the SAFE coefficient (2.11) demonstrates that perceived safety strongly influences the decision to engage in river tourism, with predicted probabilities ranging from 47.84% to 89.19% as safety perceptions improve. In India, the visitor level of perceived safety in the religious festival context partially moderates the indirect effect of place attachment on destination loyalty through emotional solidarity (Patwardhan et al., 2020). This suggests that tourism operators should prioritize physical safety measures, such as life jackets and safety briefings, and ensure that the areas surrounding the river are perceived as safe and well-maintained. By addressing these concerns, operators can enhance tourists' confidence in the safety of river tourism, thereby boosting participation.

4. Conclusion

This study’s findings indicate a notable interest in river tourism, both from local and international visitors. As society progresses, there is a distinct opportunity for Ho Chi Minh City's tourism department to capitalize on river tourism, leveraging it for profit and overall industry growth. The current participation rate of 57% is a testament to the sector's existing appeal. Key factors influencing tourist decisions include environmental concerns, safety, and the allure of new experiences, with the latter having the greatest impact. By focusing on these determinants, Ho Chi Minh City can improve the quality of its river tourism offerings. Promoting the city's unique aspects of river tourism is crucial to reshaping visitors' perceptions and enhancing their overall experience.

The implications of this study extend beyond the academic sphere, offering practical guidance for tourism operators and policymakers. First, the research highlights the importance of crafting diverse and engaging experiences that cater to a wide range of tourists. The findings suggest that to maximize the potential of river tourism, operators must go beyond passive sightseeing and offer interactive and immersive activities. This could include cultural performances, themed river cruises, or eco-friendly tours that allow tourists to experience the city's urban and natural facets.

Second, the study's findings emphasize the importance of competitive pricing strategies. The identification of cost as a significant determinant suggests that river tourism must remain accessible to a broad audience. Policymakers and businesses should consider offering tiered pricing options and promotions that appeal to budget-conscious visitors and those seeking premium experiences. By doing so, river tourism can become an inclusive activity that attracts diverse tourist segments.

Third, safety concerns, while common in tourism, take on particular importance in urban river tourism, where tourists might need to be more familiar with the unique risks associated with waterways in a city setting. The research calls attention to the necessity of ensuring rigorous safety protocols on the water and improving the perceived safety of the riverbanks and surrounding areas. This dual approach to safety can help alleviate tourists' anxieties and encourage greater participation in river tourism activities.

Finally, this study adds to the growing discourse on sustainable urban tourism by stressing the pivotal role of environmental quality in shaping tourist preferences. The expectation that urban rivers should be clean and aesthetically pleasing highlights the importance of integrating environmental management with tourism development. Policymakers are encouraged to prioritize environmental conservation efforts alongside tourism promotion, ensuring that river tourism contributes positively to the city's ecological health rather than detracting from it. This dual focus on sustainability and tourism development aligns with global trends that increasingly place environmental stewardship at the heart of the tourism industry.

However, the study's limitations, such as a small sample size and potential external socioeconomic influences, may impact the findings' broad applicability. Future research should aim to expand the sample size, consider a wider range of participants, and incorporate a more comprehensive set of variables to increase the robustness and relevance of the results. Further studies could also explore the economic impact of river tourism, assess visitor satisfaction, and evaluate the sustainability of river tourism practices. Investigating the preferences of different tourist demographics could yield insights for customizing river tourism experiences to diverse visitor needs.

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Sustainable Tourism Development in Vietnam's Central Highlands Region

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Abstract

With the advantage of unique natural resources, along with the possession of diverse and distinctive ethnic cultural identities, the Central Highlands is a land with great potential for tourism development. However, the industry of the region has not yet fully exploited its potential and existing strengths, leading to the lack of sustainability in tourism development in the Central Highlands. The purpose of this study is to analyze and evaluate the current status of tourism development in the Central Highlands as well as to point out the opportunities and challenges for sustainable tourism development in the region at present. From the formed basis, the research recommends to local authorities of provinces in the Central Highlands and the Government feasible and appropriate solutions for sustainable development of tourism in the Central Highlands in the future, contributing to the successful implementation of Resolution No. 23-NQ/TW of the Politburo on the direction of socio-economic development, ensuring national defense and security in the Central Highlands until 2030, with a vision to 2045.

Keywords: *Sustainable tourism, Central Highland, Vietnam tourism*

1. Introduction

Today, tourism has become one of the largest industries in the world. According to The World Travel & Tourism Council, in 2023, the travel & tourism sector contributed 9.1% to the global GDP; an increase of 23.2% from 2022. Many countries have used tourism as a criterion to evaluate economic development as well as the quality of life of their national communities. In particular, in the current new context, tourism development associated with the exploitation of natural resources, environmental protection, preservation and promotion of national cultural values is preferred by countries around the world to promote the sustainable development of the tourism industry.

In Vietnam, tourism is identified by the Party and State as a key economic sector and contributes a large amount of revenue to the state budget. Sustainable tourism development is always the goal of all countries in the world and Vietnam is no exception in that regard. To achieve this, in recent times, the Party and the State have issued mechanisms and policies for sustainable tourism development. Resolution No. 08-NQ/TW, dated January 16, 2017, of the Politburo, on "Developing tourism into a spearhead economic sector" emphasized the viewpoint of sustainable tourism development, preserving and promoting cultural heritages and fine traditional values of the nation, and protecting the environment and nature. The Vietnam Tourism Development Strategy to 2030 has put forward the viewpoint of "Developing tourism to truly become a spearhead economic sector, creating momentum to promote the development of other sectors and fields... Developing sustainable and inclusive tourism, on the basis of green growth, maximizing the contribution of tourism to the United Nations' sustainable development goals…" and defining the goal by 2030 "Tourism will have truly become a spearhead economic sector and developed sustainably, with Vietnam becoming a particularly attractive destination, standing among the top 30 countries in the world in terms of tourism competitiveness, and fully meeting the requirements and goals of sustainable development.

The Central Highlands includes 5 provinces: Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong, with diverse terrain, cool climate, rich natural resources, many famous landscapes and unique cultural values. The Vietnam tourism development strategy to 2030 has identified the Central Highlands as one of the 7 key tourist regions of the country with its own characteristics in terms of geographical location, socio-economics and national security and defense; natural conditions and unique cultural values of indigenous peoples, capable of creating unique tourism products imbued with Vietnamese cultural identity that can compete in domestic and international markets. In recent years, the Central Highlands has achieved many achievements in socio-economic development, including the contribution of the tourism industry. Regional tourism development is becoming an urgent task, of strategic significance and is placed at the forefront of the region's socio-economic development. However, tourism development in the Central Highlands is still unstable, unsustainable and not commensurate with the tourism potential of the region. The research purpose of this article answers the questions: What successes and limitations has tourism development in the Central Highlands achieved? And what opportunities and challenges is it currently facing? What solutions need to be implemented in the coming time to develop sustainable tourism in the Central Highlands?

Recognizing the research purpose, the content of this article is built into 7 parts. The first part is the introduction, which introduces the overall structure of the article and the purpose of writing. In the Literature review section, the arguments of different researchers related to the topic of sustainable tourism development will be synthesized, analyzed and presented systematically. The third part presents the research methods and data sources used in the article. The fourth part deals with the tourism development situation in the Central Highlands provinces. The fifth part will analyze the opportunities and challenges for tourism development in the Central Highlands. Based on the analysis and assessment from parts 4 and 5, part 6 will propose solutions for sustainable tourism development in the Central Highlands in the coming time. And finally, the study will be completed with concluding remarks.

2. Literature review

Sustainable tourism is often seen as a strategy focused on how best to encourage tourism development while minimizing possible adverse impacts. The World Tourism Organization defines sustainable tourism as: Tourism which meets the needs of present visitors, and host regions while protecting and enhancing opportunity for the future. Sustainable tourism development is envisaged as leading to management of all resources in such a way that we can fulfill economic, social and aesthetic needs while maintaining cultural integrity, essential ecological processes, and biological diversity and life support systems (UNWTO, 1996). In terms of economic activity, the concept of sustainable tourism is defined as tourism- related activities that meet certain criteria to fulfill the needs of different stakeholders and contribute to overall sustainable development (McKercher, 2003).

Sustainable Tourism is defined as: “Tourism that takes full account of its current and future economic, social, and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities.” (UNWTO, 2016).

According to Pham Trung Luong and colleagues, "Sustainable tourism development is the activity of managing the exploitation of natural and human resource values to satisfy the diverse needs of tourists while taking into account long-term economic benefits, ensuring contributions to the conservation and restoration of resources, maintaining cultural integrity, protecting the environment to develop tourism activities in the future, and contributing to improving the living standards of local communities"

The concept of sustainable tourism in Vietnam was introduced in the Vietnam Tourism Law 2014: "Sustainable tourism development meets socio-economic and environmental requirements, ensuring harmony of interests of entities participating in tourism activities while preventing any form of damage to the capability of meeting future tourism needs."

Sustainable tourism is a proven tool for development, benefitting communities in destinations around the world. As demand for global tourism continues to grow, the opportunities for sustainable development also increase. Like other economic activities, tourism both gives and takes from communities and travelers. When it is poorly planned, tourism can negatively impact cities, parks, and historic monuments, and put severe pressure on local infrastructure, resident communities, and their resources. When properly planned and managed, sustainable tourism can contribute to improved livelihoods, inclusion, cultural heritage and natural resource protection, and promote international understanding (The World Bank Group, 2017).

Although there are still some inconsistent views on the concept of sustainable tourism development, up to now, the majority of experts in the field of tourism and other related fields agree that sustainable tourism development is the managed exploitation of natural and human values to satisfy the diverse needs of tourists, focusing on long-term economic benefits while still ensuring contributions to the conservation and restoration of resources, maintaining cultural integrity for future tourism development, for environmental protection and contributing to improving the living standards of local communities.

The results of previous tourism studies (Sharpley, 2000; McKercher, 2003; Rezarta Brokaj, 2014) identified four pillars that make up sustainable tourism development: Economic sustainability: The industry is profitable in both the immediate and long term and maintains growth rates at manageable levels. This includes promoting tourism while keeping an eye on carrying capacities.

Environmental sustainability: The industry is compatible with the maintenance of biological diversity and environmental resources. A focus must be placed on the capacity of the natural and built environments to handle tourism without damage. Social sustainability: The industry helps to increase people's control over their lives and local identity. It also supports communities to absorb increasing tourist arrivals without adversely affecting or damaging indigenous culture. Local sustainability: The industry has increasing levels of local involvement in its development, and it benefits local communities. If the tourism stakeholders do not participate in the protection of the attraction or destination, there is a danger of overuse by tourists and the attraction will eventually be destroyed (Weaver and Lawton, 2006).

Seeking sustainable tourism development in order to achieve the best balance between the economic benefits and the social and environmental impacts is nowadays a challenge to many governments in the world (McKercher, 2003). Local and national authorities are increasingly using the term sustainable tourism and placing it on their agendas. This is expected to increase further in the future when the potential of sustainable tourism for employment generation and for enhancing competitiveness will become more evident (Rezarta Brokaj, 2014).

Policy and planning for sustainable tourism should reflect the opportunities, conditions and constraints of the planning zone at country or sub-country level. Four major issues in tourism planning can be outlined in the context of developing countries (Jenkins, 2015). First, governments primarily plan for tourism development. Second, the type, scale and location of tourism developments are crucial decisions in creating a sustainable sector. Careful evaluation of projects is required to optimize economic returns and to minimize negative socio-cultural and environmental impacts. This is an exceedingly difficult area of analysis and one which can be influenced by political considerations. Third, any development will depend on the availability of the necessary infrastructure. Fourth, the assurance of 'equitable distribution' of benefits is only an ideal outcome and is based on altruism rather than reality.

3. Methods

To conduct this study, the author used the following qualitative methods: First, using desk research and discourse analysis with secondary data sources collected from books, scientific journals and articles from Google Scholar, Proquest Central, Sciencedirect, Researchgate and Springer Nature to build a theoretical framework on sustainable tourism development. Second, using the method of document synthesis and analysis, content analysis, statistical analysis and historical analysis of secondary data sources such as those from tourism activity reports of 5 provinces in the Central Highlands, Statistical Yearbook of Viet Nam, and other credible websites, along with domestic and foreign scientific articles related to the content of sustainable tourism development in the Central Highlands to address the following issues: The situation of tourism development in the Central Highlands provinces. Analyzing and evaluating opportunities and challenges for tourism development in the Central Highlands. Based on the results of the assessment of the current situation and analysis of opportunities and challenges mentioned above, the author proposes solutions for sustainable development of tourism in the Central Highlands in the coming time.

4. Results

4.1. The tourism development situation in Central Highland provinces

Number of tourists

After the Covid-19 pandemic was controlled and countries allowed tourism activities to resume, the number of tourists to the Central Highlands increased significantly. In 2022, the total number of tourists to the Central Highlands increased to 7,606.3 thousand, equivalent to an increase of 225.5% compared to 2021. Among the provinces in the Central Highlands region, Lam Dong is still the locality that attracts the most tourists, accounting for 67.85% of the total number of tourists to the region, followed by Dak Lak, Kon Tum, Gia Lai, and Dak Nong (Table 1).

Table 1: Tourist arrivals in the Central Highlands region in the period 2018 – 2022

Unit: 1.000 Tourists

Set Targets	2018	2019	2020	2021	2022
Lam Dong	***6.505,5***	***7.150***	***4.000***	***2.191,2***	***7.449,4***
- International	485	533	120	18,6	150,1
- Domestic	6.020,5	6.617	3880	2.172,6	7.299,3
Dak Lak	***812***	***955***	***755,2***	***414,5***	***999,5***
- International	76	85	16,4	2,1	6,6
- Domestic	736	870	738,8	412,4	992,9
Dak Nong	***304***	***418,3***	***225,7***	***126,1***	***512,5***
- International	7,6	8,5	4	0,7	2
- Domestic	296,4	409,8	221,7	125,4	510,5
Kon Tum	***448,3***	***462***	***250,5***	***311,0***	***1.067,7***
- International	181,7	185	43,6	0	0,3
- Domestic	266,6	277	206,9	311,0	1.067,4
Gia Lai	***673,3***	***845***	***800***	***330,0***	***950,0***
- International	13,9	15	3,4	0,6	3,1
- Domestic	659,4	830	796,6	329,4	946,9
Total	**8.743,1**	**9.830,3**	**6.031,4**	**3.372,8**	**10.979,1**
- International	764,2	826,5	187,4	22	162,1
- Domestic	7.978,9	9.003,8	5.844	3.350,8	10.817

Source: Author's compilation from Tourism Activity Report of Department of Culture, Sports and Tourism of 5 provinces in the Central Highlands

Tourist markets

With advantages in space and climate, most tourists come to the Central Highlands mainly to visit and relax, accounting for over 55% of the region's visitors; in addition, there are some tourists who combine their trip with work or visit relatives. Visitors to the Central Highlands are comprised mostly of domestic tourists (Table 1), while international ones are very few, with many mainly comes from France (accounting for about 25%), followed by the US (accounting for about 12%), Taiwan (accounting for about 11%), and the UK (accounting for about 6%).

Tourism revenue

Tourism revenue in the Central Highlands region has experienced growth in recent years, with an average increase of about 10% annually before the Covid-19 pandemic. In 2022, tourism revenue increased significantly compared to 2021, with an upsurge of 127.6%, demonstrating a strong recovery of the industry. In the structure of total tourism revenue, the proportion of income from services related to travel, transportation and entertainment increased rapidly. Accommodation and food services accounted for a large proportion, contributing more than 40% of total income from tourism activities.

However, tourism revenue among localities in the region is unevenly distributed (Figure 1), with Kon Tum being the province with the lowest tourism revenue, Lam Dong showing signs of recovery after the Covid-19 pandemic, and Dak Lak becoming the brightest spot in terms of growth rate compared to other provinces in the region despite a decrease in revenue post-pandemic.

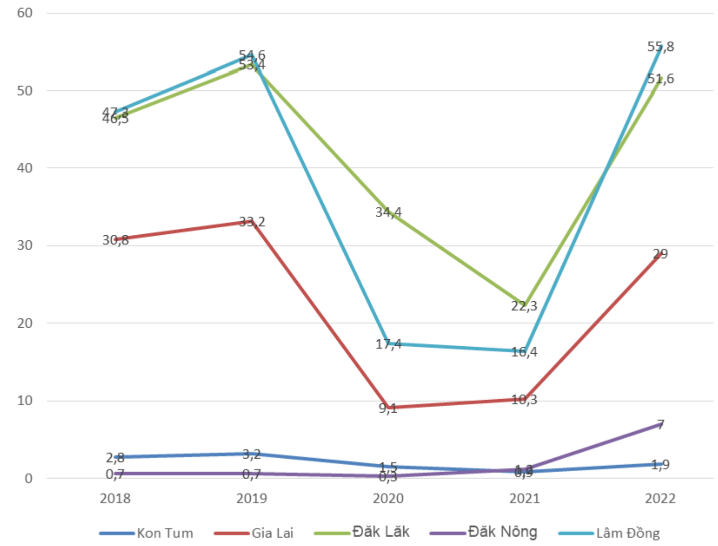

Figure 1: Turnover of travelling of localities in the Central Highlands region in the 2018-2022 period (Unit: Bill. Dongs)

Source: Statistical Yearbook of Viet Nam 2023

Tourist accommodation

The number of accommodation establishments for tourism activities in the Central Highlands provinces has been increasing over the years (Table 2), with Lam Dong playing a leading role in the tourism sector of the region. In 2022, there were 3,004 accommodation establishments in Lam Dong, accounting for more than 75% of the total number of accommodation establishments in the region, with 65.9% of which were hotels rated from 1 to 5 stars.

Table 2: The goals of accommodation facilities in the Central Highlands (Unit: facilities)

Set targets	2018	2019	2020	2021	2022
Lam Dong	1.339	2.250	2470	2.762	3.004
Dak Lak	205	212	216	228	234
Dak Nong	199	204	250	288	306
Kon Tum	141	143	149	155	194
Gia Lai	90	92	112	139	141
Total	**1.974**	**2.901**	**3.197**	**3.571**	**3.879**

Source: Author's compilation from Tourism Activity Report of Department of Culture, Sports and Tourism of 5 provinces in the Central Highlands

Tourism development in the Central Highlands is not commensurate with the existing potential, mainly due to the following shortcomings and limitations:

Firstly, Tourism revenue of the Central Highlands in the period of 2018-2022 is still the lowest among the 6 socio-economic regions, accounting for only 0.3-0.5% of the total tourism revenue of the whole country, and only a fraction of the Southeast region and the Red River Delta (Statistical Yearbook of Viet Nam 2023). These show that, compared to other regions in the country, the provinces in the Central Highlands have not fully exploited their strengths in tourism development despite having many potentials and advantages in terms of terrain, natural landscapes, climate and national cultural identity. *Secondly*, the tourism industry in the region still primarily applies traditional methods, mainly taking advantage of natural resources for development while failing to fully exploit intellectual potential or developing creative business models. *Thirdly*, activities of linking and building tourism tours associated with local events have not been promoted, thus failing to create new and unique programs and products. The tourism product chain is still in the infancy stage, and there has yet to be many unique and large-scale tourism products capable of creating a lasting impression on tourists. The service quality is still poor and incapable of competing with other localities. *Fourth*, the transport infrastructure is still insufficient and contains various issues, especially the road system being seriously degraded in many places, adversely affecting the exploitation of tourism programs connecting between localities. *Fifth*, the tourism human resources are still lacking in quantity and low in quality, especially those within workforce with foreign language skills and professional expertise who have been professionally trained. *Sixth*, the number of tourists coming to the Central Highlands is still comparatively low, especially when considering the market share of international tourists in the Central Highlands region still maintains the lowest rate in the total number of international visitors traveling between localities nationwide, reaching only 1.5% of the total tourist flow. The number of international visitors from localities is also not evenly distributed, with Lam Dong continuing to play a central role, being the main tourist center of the entire region and accounting for 92.6% of international visitors (An international airport in Lam Dong built in 2022), a significant increase compared to the pre-pandemic period, reaching about 62.4% of the total number of international visitors to this region.

The reason for the above limitations is that the development of tourism in the Central Highlands is unsustainable, has not been properly invested, suffers from lopsided development, is still closed in each locality, and has not created regional linkages. There is no joint agreement signed between the 5 Central Highlands provinces on tourism development in the region; a strategy for cooperation and development of tourism in the Central Highlands has not been developed; there is no common coordination board for orientation as well as lack of close synergizing process between localities in the region, leading to tourism products redundancy and tourists being concentrated mainly in a few provinces such as Gia Lai, Dak Lak, Lam Dong. The business efficiency of the local tourism industry, the exploitation of tourism resources, assets and capital of tourism enterprises is still low in terms of efficiency. Investment projects attracted to the tourism and service sectors, while many are hampered by slow and delayed implementation. Although there has been some level of fluidity within tourism products and services, the lack of quality and attractiveness lead to failure in meeting the increasing needs of tourists. Entertainment services are still lacking, tourist areas are small, while products overlap and are slow to innovate. the coordination between businesses in cooperation, construction and provision of tourism programs and products with strong regional and local characteristics is still being overlooked. The majority of workforce has not been received systematic training courses, with nearly 90% having only attended short-term training courses, so the general knowledge of the local geography, culture, history, and foreign language proficiency of the tour guides among the workers are still limited.

4.2. Opportunities and challenges for sustainable tourism development in the Central Highlands

4.2.1. Opportunities

The Central Highlands is considered by the Party to be a region with important strategic values in terms of national defense, security and socio-economic development of the whole country; it is one of the regions that the Party and State always pay attention to and prioritize in investment and sustainable development policies. In particular, tourism is oriented as a spearhead and important economic sector of the Central Highlands. The Party Committee and authorities of the Central Highlands provinces have directed and issued many strategic documents to orient sustainable tourism development. The inter-regional expressway network planning has been approved by the Prime Minister.

The Central Highlands has an advantage in geographical location, located at the border junction, it poses many border gates with Laos and Cambodia and has ideal conditions to expand tourism development exchanges with many regions in the country and internationally.

The Central Highlands has 53 ethnic groups living together, of which 52 ethnic minorities account for 37.65% of the region's population. Ethnic minority communities are the foundation, the driving force and the goal for sustainable development, especially for culturally specific regions such as the Central Highlands.

The Central Highlands, with its natural conditions and unique cultural values of indigenous peoples, create unique tourism products imbued with Vietnamese cultural identity, which can compete in the regional and international markets. The Central Highlands Cong Chieng Cultural Space has been recognized by UNESCO as an oral masterpiece and an intangible cultural heritage of humanity. Folk festivals and cultural festivals in the Central Highlands have become an attractive cultural tourism product for domestic and foreign tourists.

With the advantage of tourism resources, the provinces in the Central Highlands have developed a system of unique tourism products, attracting domestic and international tourists with many outstanding destinations such as Buon Ma Thuot, Da Lat, Mang Den, Dak Nong Global Geopark, Pleiku, etc.

4.2.2. Challenges

Global economic growth, global trade and investment have yet to recover to pre Covid-19 metric. Rising regional and global geopolitical conflicts are affecting the psychology and needs of international tourists. The complex developments of natural disasters and the negative impacts of climate change are causing damage and heavily affecting tourism resources. Forest degradation and massive hydropower development are negatively affecting natural resources such as landscapes, ecosystems, waterfalls, etc. Tourism activities have had negative impacts on the environment at many different levels, polluting water, land and air, along with the exploitation and overuse of natural resources. Traditional cultural values are at risk of disappearing and being distorted due to the influence of the market economy and unsustainable interference.

Inter-regional and international linkages in tourism development are still limited, mainly state management and cooperation of local authorities, while the role of enterprises and tourism associations is still being overlooked. There is no general coordination board with sufficient legal capacity to orient and implement specific and effective regional tourism development linkage activities. The issue of political security and social safety of the region causes concerns for investors developing tourism in the Central Highlands and tourism companies exploiting international visitors. There is a lack of financial and investment mechanisms for large and sustainable tourism projects. The tourism workforce in the Central Highlands is still lacking in both quantity and quality. Digital transformation of the tourism industry in regional localities is slow. The geographical location of the region is not favorable for attracting investment and developing tourism economy due to its distance from major economic centers. Road traffic infrastructure connecting the provinces in the Central Highlands and with the outside is lacking and seriously degraded; technical infrastructure for tourism and the quality of tourism products is still low. The return rate of tourists is not high, and their length of stay is short in the Central Highlands provinces. Tourists often only concentrate during certain times of the year, such as Lunar New Year, causing pressure on the response capacity of destinations. The lacking coordination between local authorities, businesses, and communities means that tourism services develop haphazardly and unprofessionally; the product value chain between localities within the region and between regions has not been formed, tourism programs and products with strong regional imprints are still few. Furthermore, there is also a lack of entertainment and shopping spots.

5. Solutions for sustainable tourism development in the Central Highlands

Recommendations to the provinces in the Central Highlands

To pay attention to developing policies, guidelines, strategic plans, plans, and projects for sustainable tourism development in the Central Highlands. In the coming time, it is necessary to establish a Coordinating Board for sustainable tourism development in the Central Highlands; develop a project for sustainable tourism development in the Central Highlands on the basis of the National Tourism Development Strategy and Plan, and a general plan for sustainable tourism development in the Central Highlands.

Synergistically build tourism infrastructure in the Central Highlands; develop aviation infrastructure to increase the ability to connect to develop intra-regional, inter-regional and international tourism. Implement the conversion and upgrading of information technology infrastructure to digital infrastructure in parallel with the national digital transformation process. Innovate the promotion and advertisement of tourism images in the Central Highlands through activities, events, festivals, and unique festivals of each locality through electronic information pages and media; increase the application of digital technology in tourism promotion and advertising activities; build a tourism information database system and exchange tourism information in the area. In addition, it is necessary to periodically organize Famtrip and Presstrip delegations to survey and research new routes and tourist destinations to promote information in domestic and international cultural and tourism events.

Develop preferential policies to create a high-quality workforce. Carry out regular training and retraining to improve management skills, work capacity and tourism expertise for officers and employees working in the industry as well as in businesses and tourist destinations. Training and fostering the local community in tourism skills and expertise according to national standards, allowing them to promote and introduce the image of local tourism; increase their participation in building development plans; raise awareness to maintain the cultural identity of the people, tourism resources associated with the community.

Encourage the development of community tourism, rural tourism, responsible tourism in ethnic minority areas, especially villages that still preserve traditional values; increase budget for the conservation and development of traditional craft villages; encourage contributions from tourism income of businesses to the conservation and restoration of cultural and ecological values, ensuring sustainable tourism development.

Orientation for tourism businesses in the area to focus on investing in developing specific tourism products such as resorts; sightseeing, studying forest ecosystems, high-tech agriculture; learning about indigenous cultural values; sports tourism, entertainment, festivals..., from there organize links and build a common brand for tourism in the Central Highlands region.

Develop a system of criteria for evaluating and classifying tourism resources and develop tourism environmental standards, on that basis, control the exploitation of tourism resources and take measures to preserve and develop tourism resources. Regulations on environmental impact assessment must be implemented in all planning and investment projects (including investment projects outside the tourism industry). Strictly handle cases of intentional violations of environmental protection regulations. Localities and relevant sectors regularly monitor changes to promptly overcome incidents and degradation of tourism resources and environment. Regarding the protection of intangible cultural resources, employ policies to create conditions to increase income and living standards for local people so that they can maintain and promote traditional occupations, craft villages, folk festivals, etc. Regularly educate and propagate local people and tourists to raise awareness of the role and significance of resources and environment for tourism activities.

Encourage tourism businesses of all economic sectors to proactively participate in international tourism associations and forums such as PATA (Pacific Asia Travel Association), ASEANTA (ASEAN Tourism Association), ASEAN Tourism Forum (ASEAN Tourism Forum) and promote propaganda and promotion activities, investment promotion, business cooperation, and tourism human resource training. Strengthen and expand cooperation to seek assistance and support in preserving and promoting resources for tourism development and environmental protection.

Recommendations to the Government

The Government needs to prioritize investment and upgrading of inter-regional transport routes connecting the Central Highlands provinces, creating conditions for the formation of typical tourist routes of the region; promulgate special incentive policies for the Central Highlands provinces in the field of investment attraction, policies to support businesses such as exemption and reduction of value added tax, corporate income tax, forest land rental tax; call on airlines and transport companies to promote and reduce ticket prices for routes to the Central Highlands.

The Ministry of Culture, Sports and Tourism should study and establish representative offices of Vietnam Tourism in foreign key to support the introduction of destination images as well as promotion of tourism in Central Highlands to the world market.

The Vietnam National Administration of Tourism support the building of a common brand for tourism in the Central Highlands region, and at the same time take the lead in linking and cooperating in developing tourism in the Central Highlands region. Support the Central Highlands provinces in developing international markets and promoting tourism in the Central Highlands provinces at activities, conferences, seminars, exhibitions, tourism promotion and advertising at home and abroad. Support the Central Highlands provinces in training tourism human resources, especially in management, professional expertise, and foreign languages.

6. Conclusion

The Central Highlands has a particularly important strategic role and position in terms of economy, politics, culture, society, environment, national defense, security and foreign affairs. Rapid and sustainable development of the Central Highlands is a major policy of the Party and the State and a continuous, central task, of great significance to the development of localities in the region and the whole country, in which priority is given to developing tourism with inherent potential and preserving cultural and historical values. In order for the natural, historical and cultural values of the Central Highlands to become an invaluable resource for the sustainable development of the "smokeless industry" of the whole region, it not only requires the synchronous implementation of effective and practical solutions but also requires the active participation of state management agencies, enterprises and local communities. With the determination and efforts of all levels of government and sectors, the active participation of the entire tourism industry, combined with the potential and advantages of tourism in the whole region, a new breakthrough will be created for the sustainable development of tourism in the Central Highlands, thereby attracting more and more domestic and foreign tourists.

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Sustainable Tourism Development in Taiwan and Implications for Vietnam

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Abstract

Sustainable tourism development has become an increasingly important issue in the current context, particularly as demand for tourism grows and environmental and social challenges become more pronounced. Governments worldwide have been implementing various regulatory tools to promote sustainable tourism development. Research on sustainable tourism policies indicates that, although countries differ in terms of conditions, resources, markets, and cultures, they all face similar challenges in developing sustainable tourism. This study focuses on analyzing sustainable tourism policies in Taiwan—a region with many similarities to Vietnam in terms of tourism development—and draws lessons for the Vietnamese tourism industry. Based on secondary data collection and expert interviews, this study proposes several strategies for managing tourism activities and promoting sustainable tourism practices in Vietnam in the future.

Keywords: *Sustainable tourism development, tourism management practices, tourism development in Taiwan*

1. Introduction

Tourism is a multifaceted economic sector characterized by its clear resource orientation, encompassing both natural and cultural resources. Its development is inherently linked to environmental considerations. Consequently, the advancement of tourism necessitates the sustainable development of society as a whole, and vice versa. Since the early 1990s, scholars globally have underscored that pursuing tourism solely for economic benefits poses significant risks to ecological environments and indigenous cultures. As a result, sustainable tourism development aims to mitigate the adverse effects of tourism activities and ensure long-term sustainability. Assessing sustainable tourism development requires specific criteria related to the type of tourism, the characteristics of tourism destinations, and tourist demographics, which are essential for formulating future tourism policies. Recently, Taiwan has emerged as a leader in implementing effective sustainable tourism strategies. Sustainable tourism development has become a central objective of Taiwan's tourism policy. The region has introduced various policies and strategies to promote sustainability, including the "National Sustainable Tourism Strategy," which seeks to protect the environment, preserve cultural values, and support local economic development (Taiwan Tourism Bureau, 2022). This strategy involves strengthening environmental protection regulations, promoting the use of renewable energy, and developing eco-friendly tourism products. Taiwan has initiated several projects aimed at safeguarding critical ecological areas and improving air and water quality. For instance, the "Biosphere Reserve Conservation and Development Project" has been instrumental in preserving vital ecosystems and enhancing community awareness of environmental conservation (Taiwan National Parks, 2021). Additionally, Taiwan emphasizes the enhancement of local community livelihoods through tourism. Taiwan has launched various programs to foster local community participation in tourism, including skill development, financial support, and the promotion of community-based tourism activities (Taiwan Community Development Association, 2023). Such community involvement not only contributes to the creation of unique tourism products but also aids in the preservation of local cultural values and traditions.

Taiwan has implemented targeted measures to ensure the sustainable development of tourism, focusing on environmental protection, cultural preservation, and the well-being of local communities. Analyzing Taiwan's tourism planning and organizational strategies provides valuable insights for other nations, including Vietnam, in fostering sustainable tourism. By adopting and integrating Taiwan's best practices in sustainable tourism management, Vietnam's tourism sector can achieve significant improvements and positive transformations in the future.

2. Methods

2.1. Data collection and processing methods

The data for this study was gathered from two sources: primary and secondary. Secondary data was collected, selected, and utilized for detailed analysis and comparison of various references, thereby shaping innovative and practical research directions. This data includes Vietnamese and English research publications on sustainable development, tourism journals, and relevant websites. Once acquired, the secondary data was processed and filtered to extract essential information for building the theoretical framework for sustainable development and assessing the status of sustainable tourism in Taiwan and Vietnam.

Primary data was obtained through in-depth interviews with experts in sustainable tourism development. After collection, this data was refined and used as a foundation for making recommendations to enhance sustainable tourism in the study area.

2.2. In-depth interview method

In-depth interviews were conducted with two experts from the tourism sector to gather insights on both objective and subjective evaluations of sustainable tourism development in the current context and to propose policy strategies that would optimize future tourism activities in the country. The data from expert interviews, combined with secondary sources, was analyzed and formed a crucial part of the research results.

2.3. SWOT analysis

The SWOT analysis method was applied to identify the internal and external factors influencing sustainable tourism development in Vietnam. Internal factors include strengths and weaknesses, while external factors include opportunities and threats. After identifying these elements, a strategic matrix was created to facilitate decision-making. The author prioritized key factor pairs with direct impact to aid in formulating urgent strategies and decisions.

3. Results

3.1. Taiwan’s experience in sustainable tourism development

Building a Green Economy – Green Tourism

Taiwan is recognized as one of the prominent destinations in East Asia with a strong orientation towards developing a green economy in tourism. To realize this goal, Taiwan has focused on three main pillars: encouraging innovation, developing a green supply chain, and promoting international cooperation. One notable initiative is the "Go Green with Taiwan" program (Taiwan Excellence, 2024), which was built on the objectives of sustainable development and a commitment to a greener future. Taiwan has also heavily invested in the research and development of new green technologies, enabling businesses to innovate, manage, and implement green practices effectively. Particularly in tourism, Taiwan has been working on building an efficient and sustainable green supply chain from production to consumption, to minimize waste and ensure environmental friendliness.

Figure 1: The campaign "Go Green with Taiwan"

Source: Taiwan Excellence

In the hotel sector, Taiwan introduced the ECO label system (Zhang & Liu, 2010) for green hotels as part of its tourism ecosystem and has certified hotels participating in the ECO label system for their environmental efforts. Five different labels are used to certify hotels, focusing on waste management, energy efficiency, water resource management, environmental education for employees, and environmental guidance in natural conservation areas. This labelling system has helped businesses gain benefits by adhering to ecological criteria, providing small enterprises with opportunities to strengthen their market position and competitiveness. Hotels have successfully improved their competitiveness by aligning operational costs with green business standards through self-assessments, which focus on five specific areas: green purchasing, environmental policy, management systems, employee training, and consumer education. Green management has enhanced hotel reputations, attracting higher-quality customers, which in turn reduces marketing costs and clarifies the hotel's positive image, potentially improving staff brand recognition (Ning & Clark, 2022) Additionally, green marketing has proven effective as consumers become more aware, exhibit positive behaviour, and recognize green hotels. They may be drawn to the concept of green hotels and participate in environmental conservation themselves. Providing a better environment while simultaneously enhancing customer education could be highly beneficial for hotels (Wang, 2012)

Furthermore, restaurants serving tourists in Taiwan have adopted green practices in waste management and the use of environmentally friendly materials, improving both internal and external operational capabilities (Hsieh & Antoine, 2023). Implementing these measures helps attract specific customer segments by offering new menu options that cater to their interests and concerns about green food, thus increasing sales compared to competitors and promoting business relationships between partners. This approach enhances environmental performance, reduces waste, and cuts costs.

Sustainable rural tourism development

Since 1998, rural tourism has become one of the key development models for rural areas in Taiwan, contributing positively to the local economy, generating income for farmers, and improving living standards in rural communities. Taiwan’s new agricultural management model has helped farmers overcome immediate challenges posed by small-scale production (Chang et al., 2020). The two main goals of this model are to meet the recreational needs of the community and to increase farmers' incomes. As a result, businesses have profited from the rural tourism model, and the "Taiwan Leisure Farm Development Association" was established in 1998 to maintain rural culture by combining agricultural resources with leisure tourism and education. This association bridges producers, businesses, the government, education, and tourism sectors. Agricultural tourism areas are built based on economic clusters and leisure farms, with core activities in animal husbandry, agriculture, forestry, and fisheries, combined with agricultural and food education. These activities are integrated with entertainment, tourism, and information technology to enhance competitiveness. Taiwan's recreational farms are divided into two types: simple and comprehensive. Comprehensive farms offer not only experience-based activities but also recreation areas, dining services, and accommodations (Lee, 2013). Over the years, this industry has successfully integrated different activities. It has provided an ideal environment for eco-tourism, promoted healthy foods and organic produce, and fostered the development of rural village crafts, paving the way for future generations. Additionally, the Taiwan Farm Travel Map has been developed to assist tourists in easily exploring agricultural tourism destinations, encouraging interaction between farmers and visitors while promoting the cultural values and local agricultural products.

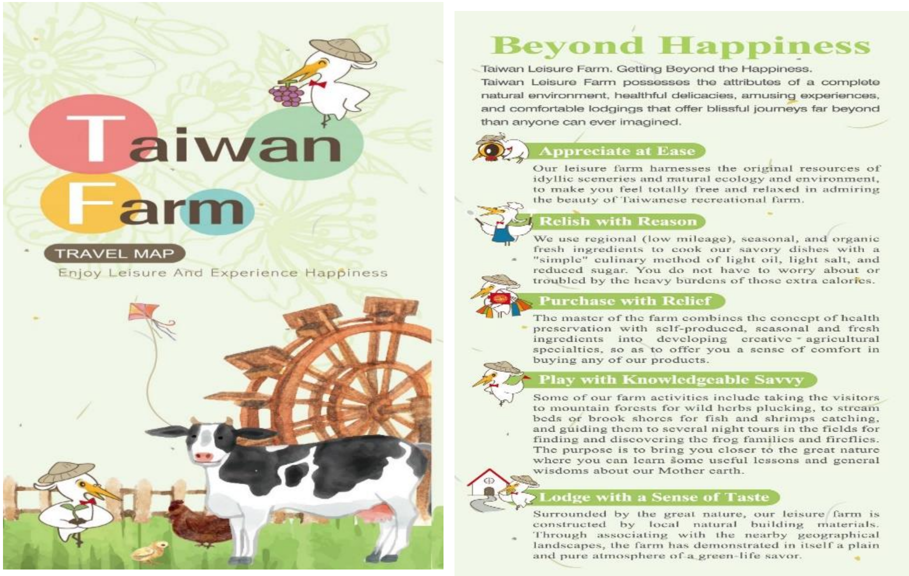

Figure 1: Taiwan Farm Travel map

Source: Taiwan Leisure Farm Development Association

Emphasizing awareness of sustainable development in community-based tourism

In Taiwan, community-based tourism is emphasized because it is considered one of the most economically sustainable forms of tourism for local populations. Community tourism helps residents protect ecological resources, while also preserving, restoring, and promoting unique local cultures. Moreover, the development of community-based tourism, especially in villages, fishing communities, and indigenous areas, is a national policy of Taiwan (Taiwan Tourism Bureau, 2011). Local residents' support and participation in tourism for sustainable development can help promote sustainable tourism (Wang, 2012). Through local involvement, communities can achieve environmental sustainability, social equity, and the desired local development. However, overexploitation of natural resources for tourism could lead to their degradation, as they are the foundation of human life and may not recover if lost. Thus, raising awareness, attitudes, and behavior towards resource usage among residents is one of the key issues in sustainable development. Although local participation is a crucial strategy for resource management, it is equally important to consider environmental and natural resource conditions to ensure that local involvement yields positive results and can be sustained for a future of sustainability.

Sustainable ecotourism development

The advancement of sustainable ecotourism in Taiwan is a central focus for the government and policymakers, aiming to both preserve natural resources and accommodate the growing demand for tourism. Taiwan is home to numerous nature reserves and national parks, including Taroko National Park, Alishan, and Sun Moon Lake..., (Zhijun, 2022). Taiwan has implemented stringent regulations to safeguard the ecosystems in these areas. These measures include visitor limits, biodiversity conservation, and the protection of rare animal and plant species. Emphasis is placed on educating and raising awareness among both the community and tourists about the significance of ecotourism. Local educational initiatives, delivered through schools and media, are designed to encourage environmental protection and responsible tourism practices. Many ecotourism destinations in Taiwan feature educational centers that inform visitors about the local ecosystem and promote participation in sustainable tourism.

3.2. SWOT analysis of sustainable tourism development in Vietnam

Strengths

Vietnam boasts numerous advantages for developing sustainable tourism. First, the country's tourism resources are vast and varied, encompassing both natural and cultural assets. Notable among these are world heritage sites such as Ha Long Bay and Phong Nha - Ke Bang, alongside cultural landmarks like the ancient town of Hoi An and the Hue Monuments Complex. Additionally, Vietnam's rich cultural diversity and historical sites, along with its traditional festivals, further enhance its tourism appeal. Moreover, the Vietnamese government has increasingly prioritized sustainable tourism through policies and strategies, such as the Sustainable Tourism Development Strategy for 2030, which encourages stakeholder involvement in promoting sustainability. As a result, local communities and businesses are becoming more aware of sustainable tourism practices, aided by support from non-governmental organizations, fostering a more sustainable and thriving tourism environment.

Weaknesses

However, Vietnam faces several inherent challenges in managing sustainable tourism. First, tourism infrastructure and management remain inconsistent, with a lack of uniform sustainability standards, leading to over-exploitation and adverse environmental impacts. Second, insufficient investment in environmental protection hampers efforts to restore areas damaged by tourism. Third, many businesses within the tourism industry have limited awareness and implementation of sustainable practices; for instance, numerous accommodation providers have yet to adopt eco-friendly measures and lack the knowledge and tools necessary for environmental protection. Lastly, the rapid development of tourism in certain regions has resulted in overcrowding and pollution, which threatens local natural and cultural resources.

Opportunities

Vietnam’s tourism sector is poised to seize numerous opportunities for sustainable growth. First, the rising global demand for eco-friendly travel creates the potential for Vietnam to offer green and environmentally conscious tourism products that appeal to this growing consumer trend. Second, policies and incentives that attract foreign investment in sustainable tourism can improve infrastructure and bolster conservation efforts. Third, international cooperation and knowledge-sharing with countries that excel in sustainable tourism, such as Japan, Thailand, and Taiwan, provide valuable models and strategies for Vietnam to adopt. Finally, enhancing education and training in sustainable tourism for local communities and businesses will not only improve service quality but also contribute significantly to environmental preservation.

Threats

Vietnam’s tourism sector also confronts several significant challenges to achieving sustainable development. The most pressing issue is climate change, which threatens tourism resources as rising sea levels and shifting weather patterns could severely damage key tourist destinations. Additionally, unchecked unsustainable practices by tourists and businesses could lead to pollution, overuse of resources, and environmental degradation. The effective implementation and monitoring of sustainability policies are further complicated by insufficient resources, manpower, and lack of consensus among stakeholders. Finally, Vietnam faces growing international competition, as other countries in the region are also developing sustainable tourism products and investing in infrastructure, presenting a challenge in maintaining its competitive edge.

Table 1: SWOT analysis of sustainable tourism management in Vietnam

Eternal Environment / Internal Environment	O: Opportunities	T: Threats
	O1. Increasing demand for sustainable tourism O2. Encouraging foreign investment O3. International cooperation and knowledge exchange O4. Strengthening education and training	T1. Impact of climate change T2. Unsustainable tourism practices by tourists and businesses T3. Challenges in policy enforcement T4. Increasing international competition
S: Strengths S1. Abundant natural resources S2. Rich culture and heritage S3. Government support policies S4. Growing public awareness	**SO STRATEGIES** S1 + S2 + S3 + O1 + O2 Develop a system of green tourism products and service providers geared towards sustainability S3 + S4 + O4 Enhance awareness and education for stakeholders in the practice of sustainable tourism	**ST STRATEGIES** S1 + S3 + S4 + T1 Build a service supply chain adapted to climate change and green economy trends in the tourism sector S3 + S4 + T2 Develop government management tools for sustainable tourism activities S2 + S4 + T4 Promote multi-channel education and outreach to raise awareness of sustainable tourism development
W: Weaknesses W1. Inconsistent management and infrastructure W2. Lack of investment in environmental conservation W3. Limited awareness and practices among businesses W4. Uncontrolled tourism development	**WO STRATEGIES** W1 + W2 + O1 + O2 Develop policies to attract tourism enterprises towards a green economy W3 + O4 Enhance cooperation with green economy organizations to foster sustainable development of domestic businesses W4 + O1 Raise tourist awareness and limit harmful tourism demands that negatively impact sustainability in the industry	

Source: Compiled by the authors

3.3. Lessons learned for sustainable tourism development in Vietnam

The sustainable tourism practices of Taiwan offer valuable insights for Vietnam in its pursuit of a greener and more responsible tourism sector. By examining Taiwan's policies for managing sustainable tourism and consulting industry experts, this paper recommends several policies that could be applied in Vietnam. Lessons from Taiwan can guide Vietnam in advancing its tourism sector sustainably through stringent resource management, promoting ecotourism, fostering community-based tourism, adopting green technology, and implementing educational programs to raise awareness.

Firstly, Taiwan has implemented stringent resource management policies to protect sensitive areas and critical ecosystems. Ecotourism sites tightly regulate visitor numbers, establish conservation areas, and set resource extraction regulations to mitigate the negative environmental impacts of tourism. Vietnam could benefit from adopting similar measures to safeguard heritage sites and important natural resources, while effectively managing and monitoring tourism activities in sensitive regions (Ruey & Chyoug, 2018).

Secondly, Taiwan has been effective in promoting ecotourism, which allows visitors to experience nature without damaging the environment. Vietnam could adopt this approach by developing ecotourism products, investing in green infrastructure, and implementing environmental protection measures in tourist destinations (Huong, 2019).

Thirdly, community-based tourism is a strong component of Taiwan's sustainable tourism model. Local communities are involved in resource management and benefit from tourism activities. Encouraging community participation enhances local ownership and responsibility for environmental and cultural preservation (Tao, 2006). Vietnam could learn from Taiwan by supporting community-based tourism projects, involving local communities in tourism planning and management, thereby enhancing both economic and social benefits.

Fourthly, the use of green technology is crucial in Taiwan's sustainable tourism model. Implementing renewable energy, reducing waste, and employing environmentally friendly technologies in accommodations and tourism services help minimize environmental impacts and improve service quality (Lin & Chang, 2011). Vietnam should promote the adoption of green technology in the tourism sector through incentives and financial support for businesses investing in clean and sustainable technologies.

Lastly, educational programs to increase awareness about sustainable tourism are essential to ensure that both tourists and local communities understand and practice sustainability principles. Taiwan has organized numerous courses, workshops, and media campaigns to educate and inform the public (Tsung, 2015). Vietnam needs to develop and implement similar programs to improve awareness among tourists and local communities regarding the importance of environmental and cultural preservation in tourism (Hsiao, 2020). Learning from Taiwan's experiences will help Vietnam establish a sustainable tourism environment, protecting both the environment and cultural heritage, and contributing to the long-term development of the tourism industry for the benefit of both communities and the environment.

4. Conclusion

Developing sustainable tourism is an ongoing and comprehensive process that requires concerted efforts and commitment from various stakeholders, including the government, businesses, and local communities. Sustainable tourism not only aims to enhance tourism activities but also ensures that such development does not harm the environment and society. The government plays a critical role in formulating necessary policies, regulations, and legal frameworks to promote sustainable tourism. These policies should include natural resource protection, effective waste management, and encouragement of green tourism practices. Additionally, the government should provide financial and technical support to implement sustainable initiatives and facilitate cooperation among stakeholders.

Businesses also play a crucial role in this process. They must adopt sustainable management practices, such as reducing waste and energy consumption and using environmentally friendly materials and products. Businesses should actively participate in green certification programs and encourage environmentally friendly behaviors among tourists. Moreover, collaborating with local communities and supporting cultural and environmental conservation efforts enhances business reputation and creates long-term sustainable value.

Local communities, as beneficiaries and managers of tourism resources, need to be actively involved in sustainable tourism development. Community participation helps preserve local cultural and traditional values and ensures that tourism activities align with local needs and aspirations. Communities should receive training and support to develop sustainable tourism products and services and be involved in decision-making related to resource management and tourism development.

Taiwan has successfully implemented sustainable tourism strategies and policies, serving as a model for others. The region has demonstrated that integrating environmental protection policies, community development, and business engagement can yield tangible benefits for both the environment and local communities. Lessons from Taiwan include developing cohesive policies, building sustainable infrastructure, and encouraging stakeholder involvement in tourism development. Vietnam can derive valuable insights from Taiwan's experience to create a sustainable tourism model tailored to its conditions and needs. Achieving this goal requires close coordination among stakeholders, including the government, businesses, and local communities. A comprehensive and integrated strategy, combined with the flexibility to adjust policies and programs based on real conditions, will be crucial for ensuring sustainable and long-term development in the tourism sector.

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Promoting Sustainable Tourism Development through Community Empowerment: A case study of Hoa Bac Commune, Da Nang City

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Abtract

This study focuses on promoting sustainable tourism development through community empowerment in Hoa Bac Commune, Da Nang City. With rich natural resources and unique local culture, Hoa Bac has significant potential to become a sustainable tourism destination. However, the lack of active community participation and ineffective management mechanisms have limited tourism development in the area. The study primarily employs qualitative methods, including in-depth interviews with community members, local authorities, and tourism businesses, to gather insights into their perceptions and experiences of tourism management. Additionally, field observations are conducted to assess the community's involvement in tourism activities. These qualitative approaches are complemented by quantitative surveys to provide a comprehensive analysis of the factors supporting or hindering community empowerment. The findings are expected to demonstrate that empowering the local community not only enhances their participation in tourism but also aids in the preservation of natural and cultural resources. Based on these insights, the study will propose strategies to further empower the community, ensuring sustainable tourism development in Hoa Bac. This research will also serve as a valuable reference for developing rural sustainable tourism models that emphasize community-based management in other regions.

Keywords: *Sustainable tourism, community empowerment, rural tourism, tourism management*

1. Introduction

Sustainable development has increasingly become a global priority, emphasizing the need to balance economic growth with environmental protection and social equity. The Vietnamese government has recognized the importance of sustainable development and has integrated it into its national strategies, particularly in rural areas where tourism can serve as a catalyst for economic growth. The 2020 National Strategy for Sustainable Development outlines the need to optimize the use of natural and human resources, ensuring that development benefits are distributed equitably across regions, including remote and rural communities (Government of Vietnam, 2020).

However, many rural areas in Vietnam, particularly those in remote and underdeveloped regions, have yet to fully benefit from national development initiatives. These communities often possess untapped potential in terms of natural beauty, cultural heritage, and unique traditions, yet they remain marginalized in the broader development process (Nguyen & Le, 2021). In response to this challenge, the government has promoted rural tourism as a key tool for sustainable economic growth through the empowerment of local communities. Rural tourism in Vietnam is seen as a significant opportunity to harness local resources for economic development while preserving cultural and environmental integrity. Vietnam's *Law on Tourism 2017* provides a legal framework for tourism development that emphasizes sustainable practices, local community involvement, and environmental protection. This law has laid the foundation for the development of tourism in rural and remote areas, aligning with the broader goal of poverty alleviation and socio-economic development (Vietnam National Administration of Tourism, 2017). Additionally, the *National Target Program on New Rural Development (NTP-NRD)* has identified rural tourism as one of the key sectors to drive economic growth and improve rural livelihoods (Government of Vietnam, 2021).

Empowering local communities to manage tourism development is critical to the success of sustainable rural tourism in Vietnam. By involving communities in decision-making, management, and benefit-sharing, tourism can become a tool for social and economic empowerment, rather than a source of external exploitation. This approach ensures that the economic benefits of tourism remain within the community, contributing to local development and the preservation of cultural identity. Moreover, community-based tourism fosters environmental stewardship, as local residents have a vested interest in protecting the natural resources that support their livelihoods (Bui et al., 2020). The Vietnamese government has also launched initiatives like the Master Plan on Tourism Development in Vietnam 2020-2030, which focuses on sustainable tourism development in rural areas, encouraging the establishment of community-based tourism models. The plan stresses the importance of promoting local products, preserving cultural heritage, and conserving the natural environment as essential components of rural tourism (Vietnam National Administration of Tourism, 2021). Thus, the process of sustainable tourism development in rural areas is closely linked to the empowerment of local communities. It involves not only the economic aspects of tourism but also the preservation of cultural values, traditions, and ecological systems that coexist with local communities. As tourism is fundamentally a community-based activity, empowering local communities becomes an essential paradigm for achieving sustainable tourism goals. Through community empowerment, rural tourism can serve as a transformative tool, improving the socio-economic quality of local residents, enhancing environmental conservation, and enriching the experiences of tourists (Pham et al., 2019).

This research focuses on evaluating the role of community empowerment in promoting sustainable tourism development in rural areas. By analyzing the case of Hoa Bac Commune in Đà Nẵng, Vietnam, the study aims to provide insights into the mechanisms through which local communities can actively participate in and benefit from sustainable tourism. Furthermore, the research will explore the barriers and opportunities for community empowerment in rural tourism, offering recommendations for policy and practice that can be applied to similar contexts The primary objective of this research is to evaluate the role of community empowerment in promoting sustainable tourism development. Specifically, the study will:

- Assess the current level of community participation in tourism activities in Hoa Bac.
- Identify the barriers and facilitators of community empowerment in the context of sustainable tourism.
- Propose strategies for enhancing community involvement and ensuring long-term sustainability in tourism development.

2. Theoretical framework

2.1. Sustainable tourism fevelopment

Sustainable tourism development involves a comprehensive approach that considers the economic, social, and environmental impacts of tourism, both in the present and future. It aims to address the diverse needs of visitors, the tourism industry, the environment, and local communities (UNWTO, 2020). At the heart of sustainable tourism is the effort to balance the economic advantages of tourism with the need to minimize negative effects on the environment and local cultures. This framework is founded on three essential principles: environmental sustainability, social equity, and economic viability.

First, environmental sustainability seeks to ensure the preservation of natural resources while limiting environmental degradation. Secondly, social equity strives to fairly distribute the benefits of tourism, particularly among local communities and marginalized groups. Finally, economic viability focuses on developing tourism in ways that provide long-term economic benefits for both local communities and the tourism sector itself (Bramwell & Lane, 2019).

In Vietnam, the National Strategy for Sustainable Development underscores the importance of integrating sustainability principles across all sectors, with a particular emphasis on tourism. The strategy advocates for responsible tourism practices that prioritize the conservation of both cultural and natural heritage, while simultaneously enhancing the livelihoods of local populations (VNAT, 2021).

2.2. Community empowerment in tourism

Community empowerment refers to the process by which local communities gain control over decisions and activities that directly affect their livelihoods, particularly in relation to economic development and resource management (Scheyvens, 1999). In the tourism context, empowerment is key to ensuring that local populations are actively involved in all phases of tourism development, including decision-making, management, and benefit-sharing. This involvement is essential for fostering sustainable tourism that benefits both the community and the tourism industry.

Community empowerment in tourism can be understood across several dimensions. Economic empowerment occurs when local communities derive financial benefits from tourism, be it through employment, entrepreneurship, or the establishment of community-based enterprises (Nguyen & Bui, 2020). Social and political empowerment, on the other hand, provides communities with a voice in tourism governance, allowing them to actively participate in decision-making processes and ensuring that their concerns are adequately addressed (Hall, 2019). Finally, cultural empowerment enables communities to preserve and promote their cultural heritage through tourism, thereby reinforcing their cultural identity while simultaneously creating new economic opportunities (Cole, 2020).

Research indicates that when local communities are involved in the planning and management of tourism initiatives, they are more inclined to support environmental conservation efforts. Furthermore, such involvement ensures that the benefits of tourism are distributed equitably among community members (Bui et al., 2021).

2.3. Barriers to community empowerment

Despite the clear advantages of community empowerment, several obstacles continue to impede the effective participation of local communities in tourism development. One of the most significant barriers is the lack of resources and capacity. Many rural communities lack the financial resources, technical expertise, and knowledge necessary to manage tourism effectively (Bui & Pham, 2020). Additionally, institutional challenges often arise, particularly when government policies fail to fully support community-based tourism or when there are conflicts between local communities and external stakeholders, such as tourism developers or government agencies (Hall, 2020). Another common obstacle is the limited access to tourism markets, which prevents rural communities from promoting their destinations and attracting potential visitors, thereby restricting their ability to generate income from tourism activities (Le et al., 2019).

Overcoming these barriers requires targeted strategies, such as capacity-building programs that equip communities with the skills and resources needed to manage tourism effectively. Equally important are supportive government policies that promote community involvement and collaboration with the private sector, fostering partnerships that prioritize equitable benefit-sharing and sustainable tourism development.

2.4. Models of community-based tourism (CBT)

Community-Based Tourism (CBT) is a development model in which local communities actively participate in the planning, management, and execution of tourism activities. The primary objective of the CBT model is to ensure that tourism not only generates economic benefits for the community but also contributes to the preservation of local culture and the environment. Successful CBT models are characterized by several key features that contribute to their long-term viability and positive impact on the community.

First and foremost, strong local leadership is essential to the effectiveness of CBT initiatives. Committed leaders within the community play a pivotal role in mobilizing local resources and fostering partnerships with external stakeholders, such as government agencies or private enterprises, to ensure the success of tourism projects (Goodwin, 2019). Moreover, collaborative governance is another critical component of CBT projects. These initiatives often rely on cooperation between the local community, governmental bodies, and the private sector, ensuring that the community's voice is adequately represented in the decision-making process (Jamal & Camargo, 2020).

Finally, a focus on sustainability is central to the success of CBT. Sustainable CBT projects prioritize long-term goals by promoting tourism that is low-impact and culturally sensitive, thereby benefiting the community while simultaneously preserving local resources and heritage (Tosun, 2019). By adhering to these principles, CBT models can create a sustainable and inclusive framework that supports both economic development and cultural conservation.

2.5. Vietnam's legal and policy framework for sustainable rural tourism

The Vietnamese government has established a robust legal framework to support sustainable tourism development, particularly in rural areas. The *2017 Law on Tourism* emphasizes the importance of community participation in tourism development and encourages sustainable practices. Furthermore, the *National Target Program on New Rural Development* identifies rural tourism as a key driver of economic growth and poverty alleviation in rural areas (Government of Vietnam, 2021). These policies promote the creation of community-based tourism initiatives that empower local communities to manage and benefit from tourism activities, ensuring that tourism development aligns with sustainability principles.

3. Methods

3.1. Research design

This study employs a qualitative research design to explore the role of community empowerment in sustainable tourism development in Hoa Bac Commune, Đà Nẵng. The qualitative approach is chosen because it allows for an in-depth understanding of participants' perspectives, experiences, and insights regarding tourism development and community participation. The research will focus on gathering rich, descriptive data through in-depth interviews with key stakeholders, including local government officials, community representatives, and tourism entrepreneurs involved in tourism activities in Hoa Bac.

The primary objective of this qualitative research is to examine the complex dynamics of community empowerment, identifying both the challenges and opportunities for sustainable tourism in the region. The research design is based on an exploratory framework, seeking to uncover underlying patterns and themes that contribute to the understanding of how community empowerment impacts sustainable tourism.

3.2. Research methods

Sampling

This investigation uses purposive sampling to select participants who have direct involvement in tourism development and management in Hoa Bac. The selected participants will include:

- Local government officials: Individuals responsible for tourism policies and development in the commune.
- Community representatives: Leaders or influential members of the local community who are actively involved in tourism initiatives.
- Tourism entrepreneurs: Business owners and operators who manage tourism services such as homestays, tours, and other tourism-related activities in the region.

The sample size will consist of approximately 15-20 participants, ensuring a range of perspectives from different stakeholder groups. The sample size is determined based on the principle of saturation, where data collection will continue until no new themes or insights emerge.

Data collection

The primary data collection method will be semi-structured in-depth interviews. This method allows for flexibility in the interview process, enabling the researcher to explore key themes while allowing participants the freedom to express their views in detail. Each interview will last approximately 45 to 60 minutes, and interviews will be conducted either face-to-face or through online platforms, depending on participant availability and logistical considerations.

Data analysis

The qualitative data collected through interviews will be analyzed using thematic analysis. This method is suitable for identifying, analyzing, and reporting patterns (themes) within the data.

Validity and reliability

To enhance the credibility and trustworthiness of the research, the following strategies will be employed:

- Triangulation: Data will be cross-verified by comparing perspectives from different stakeholder groups (government officials, community representatives, and tourism entrepreneurs).
- Member checking: Preliminary findings will be shared with participants to ensure that their views have been accurately captured and interpreted.
- Rich, thick descriptions: The research will provide detailed descriptions of the context, participants, and findings to allow readers to assess the transferability of the results to similar settings.
- Reflexivity: The researcher will maintain a reflexive journal throughout the research process, documenting personal reflections and potential biases that could influence data collection and analysis.

3.3. Ethical considerations

Ethical considerations are a critical component of this research. The study will adhere to the following ethical principles:

- Informed consent: All participants will be fully informed about the purpose of the research, their role in the study, and their right to withdraw at any time without penalty. Written or verbal consent will be obtained before the interviews.
- Confidentiality: The privacy of participants will be protected by anonymizing their responses and ensuring that identifying information is not disclosed in the final report.
- Data protection: All audio recordings, transcripts, and research notes will be securely stored and accessible only to the researcher.
- Cultural sensitivity: Given the cultural significance of tourism in Hoa Bac, the researcher will take care to respect local customs and values throughout the research process.

4. Results and Discussion

4.1. Assessing the current level of community participation in tourism activities in Hoa Bac

In-depth interviews with local stakeholders—including community leaders, tourism entrepreneurs, and government officials—reveal a moderate level of community participation in tourism activities in Hoa Bac. Participation varies significantly across demographic factors such as age, occupation, and education level, and is characterized by limited direct involvement from the majority of the local population.

A prominent observation from the interviews is the minimal direct engagement of many community members in tourism operations. Although some individuals engage in small-scale tourism initiatives, such as operating homestays or offering guiding services, these activities remain relatively isolated. A local community leader described the situation: "*Most people here are still unsure how to get involved in tourism. Some manage small homestays or sell local products, but many feel they lack the necessary skills or knowledge to truly benefit from it*." This highlights a significant gap in the tourism value chain, where a lack of knowledge and experience in tourism management prevents full integration of the local population. The absence of formal training and limited exposure to tourism practices leave many unprepared to undertake more active roles in the development and management of tourism activities.

Furthermore, the findings indicate a passive form of engagement among many community members. Instead of playing an active role in the planning or execution of tourism projects, most individuals participate in secondary roles, providing services when needed or supporting external operators without taking ownership of the initiatives. A tourism entrepreneur explained the challenge: "*We've been trying to promote eco-tours and cultural experiences, but it's hard to get the community involved. They don't really see how it could benefit them, and they lack the training to work effectively with tourists*." This lack of proactive involvement stems not only from limited skills but also from a lack of understanding about the potential benefits of tourism.

Additionally, the early stages of community-based tourism (CBT) initiatives, supported by external NGOs and local government, have not yet achieved widespread community involvement. These efforts remain limited to a small group of individuals who have managed to leverage external support and training.

An important dynamic to consider is the variation in participation across different demographic groups. Younger community members, in particular, exhibit greater enthusiasm for engaging in tourism-related activities, driven by interests in areas such as digital marketing and ecotourism guiding. A young participant reflected: "*I'm interested in learning how to use social media to attract tourists, but we lack sufficient training programs or resources to help us get started.*" This showcases a growing interest among younger community members in using technology to promote tourism, though their potential remains largely untapped due to inadequate training opportunities.

In contrast, older residents tend to participate less due to unfamiliarity with tourism operations and skepticism about the benefits of tourism. This generational divide highlights the need for targeted training programs tailored to different age groups and skill levels within the community.

While the foundation for community participation in tourism in Hoa Bac exists, several challenges must be addressed to enhance involvement and sustainability. The observed passive engagement suggests a need for capacity building and educational initiatives. Training programs that provide practical skills in tourism management, customer service, and marketing could empower community members to take on more active roles and foster a sense of ownership over tourism initiatives.

Social dynamics also play a crucial role in shaping participation. The willingness of younger residents to engage in tourism presents an opportunity to focus efforts on this demographic as a key driver of tourism development. For instance, training in digital marketing could enable these individuals to effectively promote local tourism offerings, bridging the gap between the community and potential visitors.

Community-based tourism initiatives lay the groundwork for sustainable tourism development; however, these need to be scaled up and made more inclusive. Collaboration between local government, NGOs, and the community is essential to expand these programs and ensure they reach a broader segment of the population.

Finally, the perceived lack of benefits from tourism, as voiced by several interviewees, underscores the need for better communication about the economic and social advantages that tourism can offer. Government and NGO initiatives should focus on showcasing successful case studies from other regions where community involvement in tourism has improved livelihoods. Such examples could inspire more community members to actively participate and view tourism as a viable path to economic development.

In conclusion, while the current level of community participation in tourism in Hoa Bac is moderate, there is significant potential for growth. Addressing skill gaps, resource limitations, and generational differences, combined with enhanced support for community-based tourism initiatives, can lead to greater and more sustainable involvement of the local population in tourism activities.

4.2. Identifying the barriers and facilitators of community empowerment in the context of sustainable sourism

Barriers to community empowerment

In-depth interviews with key stakeholders revealed several significant barriers to community empowerment within the tourism sector. Among the most prominent obstacles are a lack of tourism-related skills, inadequate financial resources, and weak institutional support. These challenges collectively restrict the community's ability to engage fully in sustainable tourism development.

One of the most pressing barriers is the limited skills and education among local residents. Many community members lack expertise in key areas such as tourism management, customer service, and marketing, which impedes their ability to participate meaningfully in tourism initiatives. As one local government official noted, "*We have policies in place to support tourism, but implementation is difficult* *because the community lacks the necessary skills, and we do not have sufficient resources to provide comprehensive training programs*." This statement underscores the institutional gaps, particularly in terms of capacity building. Although government policies exist to support tourism development, the absence of adequate training programs has left the community ill-equipped to fully capitalize on tourism opportunities.

Financial constraints also pose a significant challenge. Many local businesses struggle to secure the investment necessary to expand tourism infrastructure, including homestays, transportation services, and marketing efforts. A community representative explained, "*It's difficult for us to start a business or expand our homestays because we lack the financial resources or access to loans. Banks do not consider us viable investments, so we are forced to rely on small-scale tourism*." This lack of access to capital severely hampers local entrepreneurship, limiting the ability of the community to scale up its tourism initiatives. In the absence of strong financial support systems, such as micro-loans or grants, many community members must rely on personal savings or small-scale operations, which are unsustainable in the long run.

Institutional weaknesses further exacerbate the situation. While government initiatives exist to promote tourism, the implementation of these policies is often fragmented and inconsistent. Interviewees pointed to the lack of clear guidelines and insufficient investment in essential infrastructure, such as roads and tourism facilities, which has hindered the growth of tourism in Hoa Bac. Without robust institutional backing, the community remains unable to independently develop and sustain tourism initiatives.

Cultural and social barriers also emerged as significant challenges. Some community members are resistant to change, particularly when it comes to adapting their traditional ways of life to accommodate tourism. There is a widespread concern that tourism may negatively impact local culture and lead to the commodification of traditions. One interviewee expressed, "*We want to share our culture with visitors, but we don't want it to be exploited or changed*." This sentiment reflects the complex social dynamics that can arise when tourism is introduced to rural communities. The fear of cultural loss or exploitation can deter broader community participation in tourism, particularly among older generations who are more protective of their cultural heritage.

However, despite these barriers, the research also identified several facilitators that have supported community empowerment in tourism development. External support from stakeholders, particularly NGOs and international agencies, has been instrumental in providing training, resources, and financial assistance. As one tourism entrepreneur noted, "*We've been lucky to receive support from some NGOs who provided us with basic training in hospitality and marketing. This has helped us get started, but we need more support if we want to expand*." This demonstrates how external assistance has empowered certain individuals to launch small-scale tourism enterprises, laying the foundation for future growth. Nevertheless, continued support is necessary to ensure the sustainability of these initiatives.

The growing demand for ecotourism has also been a positive driver for community involvement. Tourists increasingly seek authentic, nature-based experiences, which align well with the natural and cultural assets of Hoa Bac. A local leader remarked, "*Visitors come here because they want an authentic experience. They want to see how we live and experience our culture. This is an opportunity for us, but we need the right training and support to make it sustainable*." While ecotourism offers considerable potential for the community, adequate training and support remain critical to ensure that these opportunities are realized in a sustainable manner.

Finally, recent government initiatives have begun to prioritize tourism development as part of a broader economic strategy for rural areas. Local government efforts have included investments in infrastructure improvements and marketing campaigns to promote Hoa Bac as a destination. However, more targeted support is needed to ensure that community-based tourism (CBT) initiatives are strengthened, and that the benefits of tourism are distributed equitably among all community members.

In summary, while there are substantial barriers to community empowerment in tourism development, there are also promising facilitators that can help overcome these challenges. The most pressing issue remains the community's lack of skills and resources, which hinders its ability to fully leverage the growing demand for sustainable tourism. Addressing these barriers through capacity-building programs and improved access to financial resources is essential to empowering the community to play a more active role in tourism development. External support from NGOs and other stakeholders has proven crucial in initiating tourism projects, but for these efforts to be sustainable in the long term, both government and external agencies must provide consistent and structured support. This includes not only initial training but also ongoing assistance to help local entrepreneurs scale their businesses and adapt to evolving market conditions. Furthermore, addressing cultural concerns and ensuring that tourism development respects local traditions and values will be vital in fostering broader community participation. Ultimately, community-based tourism models that prioritize cultural preservation and environmental sustainability can help mitigate fears of cultural commodification, while aligning tourism development with the community's long-term interests.

4.3. Propose strategies for enhancing community involvement and ensuring long-term sustainability in tourism development

Based on the research findings, several strategies are proposed to enhance community involvement and ensure the long-term sustainability of tourism development in Hoa Bac. These strategies focus on capacity building, institutional support, cultural preservation, infrastructure development, and marketing efforts. Addressing these key areas will enable the local community to play a more active role in tourism development while preserving its cultural and environmental resources.

Capacity building and training programs

Capacity building and training emerged as one of the most critical issues facing the local community. Many residents lack the necessary skills to effectively manage and participate in tourism, including competencies in hospitality, marketing, and business management. A local government official emphasized the importance of this issue: "*Without proper training, the community won't be able to manage tourism on their own. We need to create more educational programs that focus on hospitality, business management, and environmental sustainability*." To address this challenge, targeted training programs must be developed in collaboration with local universities, NGOs, and tourism agencies. These programs should emphasize practical skills such as tourism management, customer service, and digital marketing. Furthermore, promoting entrepreneurship in tourism through micro-loans, grants, and mentorship programs will empower community members to establish and manage their own tourism businesses. A tourism entrepreneur expressed the need for hands-on support: "*We need more workshops and practical training that teach us how to manage tourism professionally. It's not just about running a homestay; it's about understanding the entire business model.*"

Strengthening institutional support

Strengthening institutional support is another critical strategy to enhance community participation in tourism. The local government must establish clear and supportive policies that facilitate the development of community-based tourism (CBT), including zoning regulations, tourism licensing, and financial incentives for local entrepreneurs. A government official noted the need for collaboration: "*We can't do this alone. We need partnerships between the government, local businesses, and the community to develop tourism in a way that benefits everyone*." Public-private partnerships can also play a key role in pooling resources and sharing risks, ensuring that tourism projects are managed effectively and that local communities benefit both economically and socially.

Promoting cultural preservation through tourism

A significant concern among community members is the potential impact of tourism on their cultural heritage. Many fear that tourism may commodify or alter their traditions. A community representative expressed this concern: "*We want to share our culture with visitors, but we don't want it to be exploited or changed. Tourism should help us preserve our traditions, not destroy them.*" To mitigate these concerns, culturally sensitive tourism policies must be implemented to ensure that tourism activities respect and enhance local traditions. Initiatives such as community-run cultural centers, traditional craft workshops, and local festivals can help preserve cultural heritage while providing economic benefits. These initiatives should involve active participation from the community to ensure they align with local values and practices.

Infrastructure development

Infrastructure development was also identified as a key area for improvement. Without adequate infrastructure, such as roads and transportation, the community's ability to attract and accommodate tourists is severely limited. A local business owner highlighted this issue: "*Right now, the roads to our village are not good, and it's difficult for tourists to get here. If we want to grow tourism, we need better infrastructure, especially transportation and accommodations*." Improving transportation infrastructure will facilitate easier access to Hoa Bac for tourists and provide broader benefits for the community. Additionally, the development of eco-friendly accommodations, such as eco-lodges and homestays, will attract tourists seeking authentic experiences while maintaining environmental sustainability.

Marketing and promotion

Effective marketing and promotion are essential to increasing the visibility of Hoa Bac as a tourism destination. Training community members in digital marketing and social media usage is critical for promoting local tourism products and services. A young tourism entrepreneur emphasized the importance of this skill: "*If we can learn how to use social media effectively, we could reach more tourists. We need support to build our brand and promote what Hoa Bac has to offer*." Developing a destination brand for Hoa Bac, focusing on its natural beauty, cultural heritage, and eco-friendly tourism offerings, will help attract both domestic and international tourists. A strong brand identity will enable the community to differentiate itself from other tourism destinations, highlighting its unique selling points.

The proposed strategies underscore the need for a multi-faceted approach to sustainable tourism development in Hoa Bac. Capacity building and institutional support are foundational to ensuring that the community can engage more actively in tourism and reap its benefits. These efforts must be complemented by cultural preservation initiatives, ensuring that tourism development aligns with the community's cultural values and traditions.

Additionally, infrastructure development is crucial for enabling sustainable growth in tourism. Improved transportation and eco-friendly accommodations are necessary to increase tourist access while preserving the environmental integrity of the region.

Finally, marketing and promotion are vital to positioning Hoa Bac as a competitive tourism destination. By training local entrepreneurs in digital marketing and developing a cohesive destination brand, the community can enhance its visibility and attract a broader range of tourists.

For tourism development in Hoa Bac to be both inclusive and sustainable, these strategies must be implemented in a manner that empowers the community to take a leading role in shaping the future of tourism. By focusing on education, collaboration, cultural preservation, and marketing, the community can achieve long-term sustainability in tourism while safeguarding its cultural and environmental assets.

5. Conclusion

The present study has explored the role of community empowerment in promoting sustainable tourism development in Hoa Bac. Through in-depth interviews with local stakeholders, it was found that while the community demonstrates a moderate level of involvement in tourism activities, significant barriers such as a lack of skills, financial resources, and institutional support limit their full participation. However, the growing demand for ecotourism, coupled with external support from NGOs and government initiatives, presents a promising opportunity for enhancing community engagement.

Several strategies have been proposed to address these challenges, including capacity building, strengthening institutional support, promoting cultural preservation, infrastructure development, and improving marketing efforts. These strategies are essential for empowering the community to take a leading role in tourism development while ensuring the long-term sustainability of both the environment and local culture.

In conclusion, the future success of tourism in Hoa Bac hinges on a multi-stakeholder approach that prioritizes education, collaboration, and cultural integrity. By implementing these strategies, the community can develop a sustainable tourism model that not only provides economic benefits but also preserves its rich cultural and natural heritage for future generations.

6. Research Limitations

Limited Sample Size: Due to time and resource constraints, the number of participants in the study was relatively small, focusing primarily on key stakeholders such as local government officials, community representatives, and tourism entrepreneurs. While this provided valuable insights, the findings may not fully represent the perspectives of the broader community in Hoa Bac.

Geographical Constraints: The study was conducted in a single commune, Hoa Bac, which limits the generalizability of the findings to other rural areas in Vietnam. The unique cultural and environmental context of Hoa Bac means that the results may not be directly applicable to different regions with varying socio-economic and cultural conditions.

Qualitative Methodology: The study employed a qualitative approach, which provides in-depth understanding but may lack the statistical generalizability of quantitative methods. As a result, the findings are based on subjective interpretations of interview data, which could be influenced by personal biases of both the researcher and participants.

Limited Time for Longitudinal Analysis: This research was conducted within a limited timeframe, preventing a long-term analysis of the impacts of community empowerment and sustainable tourism development. A longitudinal study would provide more comprehensive insights into how community involvement evolves over time and its sustained impact on tourism development.

Access to Resources and Infrastructure: The study also faced challenges in accessing remote areas within Hoa Bac, which may have limited the ability to collect data from more diverse segments of the population, especially those in more isolated locations.

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Sustainable Tourism in Vietnam: A Comparative case study of Community Involvement, Conservation, and Cultural Preservation

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Abstract

This paper conducts a comparative analysis of sustainable tourism practices across five case studies in Vietnam: Sapa O'Chau, Pu Luong Nature Reserve, Mekong Delta Homestays, Con Dao Islands, and Hoi An. Each case represents a distinct approach to sustainable tourism, including community-based tourism, ecotourism, marine conservation, and urban heritage tourism. The analysis identifies common themes such as the central role of community involvement, the integration of environmental conservation with tourism development, and the importance of economic benefits for local populations. Differences in approaches highlight the unique contexts and challenges faced by each region, from cultural preservation to biodiversity protection. Factors contributing to the success of these initiatives include strong collaboration between local communities, government bodies, and international organizations, as well as effective management of environmental impacts. The paper also examines ongoing challenges, such as managing tourist numbers and maintaining cultural authenticity. The findings provide valuable insights into how sustainable tourism practices can be adapted, expanded, and integrated across Vietnam to promote long-term sustainability, community well-being, and conservation.

Keywords: *Community-based tourism, environmental conservation, sustainable tourism development*

1. Introduction

Vietnam, with its diverse landscapes, rich cultural heritage, and warm hospitality, has become a prominent destination for both international and domestic travelers (Nguyen & Tran, 2022). From the bustling streets of Hanoi and Ho Chi Minh City to the tranquil beauty of Ha Long Bay and the cultural heritage of Hoi An, the country offers a wide range of experiences (Vietnam National Administration of Tourism, 2023). However, the rapid growth of the tourism industry has brought with it significant environmental, social, and cultural challenges, such as degradation of natural resources, increased pollution, and pressures on local communities (Hoang, 2020). These challenges underscore the urgent need for sustainable tourism practices that can safeguard Vietnam's natural and cultural assets while supporting the livelihoods of local communities (Le & Pham, 2021).

According to the United Nations World Tourism Organization (UNWTO), sustainable tourism is defined as tourism that considers its current and future economic, social, and environmental impacts, while addressing the needs of visitors, the industry, the environment, and host communities (UNWTO, 2019). In Vietnam, various innovative initiatives have been launched in line with this definition, aiming to balance the country's tourism growth with the preservation of its unique heritage and natural environment (Nguyen, 2021). These initiatives include eco-tourism projects, community-based tourism, and the adoption of renewable energy in hospitality operations, all of which are designed to promote sustainable practices and minimize the adverse effects of tourism (Pham et al., 2020).

This paper explores case studies of sustainable tourism initiatives in Vietnam, highlighting how different regions and communities are addressing the challenges of tourism development. Through detailed examination of these initiatives, the essay aims to provide insights into the strategies, successes, and obstacles associated with sustainable tourism in Vietnam, ultimately offering recommendations for future development (Tran & Le, 2022).

2. Methods

In this research, a comparative analysis of five sustainable tourism case studies in Vietnam was conducted to identify common themes, strategies, and challenges. The selected case studies—Sapa O'Chau, Pu Luong Nature Reserve, Mekong Delta Homestays, Con Dao Islands, and Hoi An—represent diverse regions and approaches to sustainable tourism, including community-based tourism, ecotourism, marine conservation, and urban heritage tourism. Data for the analysis were collected through a review of existing literature, reports, and policy documents related to each case. The analysis focused on key aspects of sustainability, such as community involvement, environmental conservation, and economic impact, to draw comparisons across different models of tourism development. By examining the unique contexts and outcomes of each initiative, this methodology allowed for an in-depth understanding of the factors contributing to both successes and challenges in implementing sustainable tourism practices in Vietnam. The findings provide insights into how sustainable tourism can be adapted and expanded to other regions in the country.

3. Results

3.1. Case Study 1: Sapa O'Chau – Ethnic Minority-Led Tourism

3.1.1. Background and overview

Sapa O'Chau, situated in the mountainous region of Sapa in northern Vietnam, is a prominent example of community-based tourism led by ethnic minorities. The region is home to several ethnic groups, including the Hmong, Dao, and Tay, each with its own distinct cultural practices and traditions (Hoang & Le, 2018). Founded in 2009 by Shu Tan, a member of the Hmong ethnic group, Sapa O'Chau was created with the vision of empowering local communities through tourism while preserving their cultural heritage (Nguyen, 2019). The initiative aims to provide sustainable tourism experiences that both celebrate the local culture and benefit the community economically and socially.

3.1.2. Sustainable practices and community involvement

Sapa O'Chau is based on the principles of community-based tourism, which encourages local residents to take an active role in managing tourism activities (Pham & Tran, 2020). It provides employment opportunities for ethnic minority women and youth, who work as guides, hosts, and artisans. Tourists are offered immersive experiences such as trekking through the terraced rice fields, staying in traditional Hmong homes, and participating in cultural workshops that showcase local crafts and customs (Nguyen, 2019). This approach not only allows visitors to experience authentic local culture but also ensures that tourism revenue directly supports the local community.

One of the key sustainable practices at Sapa O'Chau is the focus on **low-impact tourism**. Treks and tours are designed to minimize environmental damage, and visitors are educated on respecting local traditions and natural resources (Hoang & Le, 2018). Additionally, Sapa O'Chau reinvests tourism revenue into community development projects, such as improving education and healthcare services, which further enhances the well-being of local residents (Nguyen, 2019).

3.1.3. Impact on local communities and environment

The impact of Sapa O'Chau on the local community has been profound. By providing a stable income source, it has reduced the need for seasonal migration, particularly among ethnic minority families, who previously had to leave the region in search of work (Le & Pham, 2021). Moreover, by promoting and preserving cultural heritage, the initiative has helped safeguard traditional practices that might otherwise have been eroded by modernization and external influences (Pham & Tran, 2020).

Environmentally, Sapa O'Chau has raised awareness about the importance of protecting the natural landscape. The community has undertaken efforts to prevent deforestation and manage waste, particularly the growing issue of plastic pollution in tourist areas (Hoang & Le, 2018). These measures have contributed to preserving the stunning natural scenery of Sapa, which is one of the region's main attractions.

3.1.4. Challenges faced and lessons learned

Despite its successes, Sapa O'Chau faces several challenges. The rapid increase in tourism has put additional pressure on the local environment, particularly in terms of waste management, which has become more difficult to manage as tourist numbers grow (Nguyen, 2019). Furthermore, there is the ongoing challenge of maintaining cultural authenticity in the face of commercialization, as tourism develops more rapidly (Pham & Tran, 2020).

One of the critical lessons learned from Sapa O'Chau is the importance of community involvement in tourism management. By giving local people control over tourism activities, the initiative has ensured that the benefits are distributed more equitably and that the community has a vested interest in maintaining sustainable practices (Le & Pham, 2021). However, to sustain these achievements, continuous efforts are required to address environmental challenges and ensure that the growth of tourism does not compromise the natural and cultural resources it seeks to highlight.

3.2. Case Study 2: Pu Luong Nature Reserve – Ecotourism and Conservation

3.2.1. Background and overview

Pu Luong Nature Reserve, located in Thanh Hoa Province, is a notable example of sustainable tourism in Vietnam. Established in 1999, the reserve covers over 17,600 hectares and is rich in biodiversity, featuring tropical forests, limestone karsts, and rice terraces (Le & Pham, 2021). The area is home to various ethnic minority groups, including the Thai and Muong people, who have lived in harmony with the environment for generations (Nguyen & Hoang, 2020). Pu Luong has become a model for ecotourism that integrates conservation efforts with community benefits, balancing tourism development with the preservation of its natural and cultural heritage.

3.2.2. Ecotourism practices and conservation efforts

Ecotourism in Pu Luong is centered around offering visitors the opportunity to experience nature while contributing to its conservation. Activities include guided treks through the forest, visits to traditional stilt houses, and cultural exchanges with local communities (Pham et al., 2019). These tours are designed to minimize environmental impact, with a portion of the revenue generated being reinvested into conservation initiatives.

The reserve has implemented several key conservation initiatives, including reforestation programs, wildlife monitoring, and environmental education for both locals and visitors (Le & Pham, 2021). These efforts are aimed at safeguarding Pu Luong's unique biodiversity, which includes endangered species such as the Delacour's langur and the white-collared bear (Nguyen & Hoang, 2020). By integrating conservation into tourism, the reserve has fostered a sustainable approach to preserving its ecological integrity.

3.2.3. Collaboration with local communities

A central component of Pu Luong's ecotourism model is its strong collaboration with local communities. The reserve management works closely with village leaders to ensure that tourism activities benefit the local population. This includes offering training programs that enable locals to work as guides, cooks, and hosts, providing them with alternative livelihoods and reducing their reliance on traditional agriculture or logging (Tran & Vo, 2022).

Local communities are also actively involved in decision-making processes related to tourism development within the reserve, fostering a participatory approach that strengthens trust between management and local residents (Pham et al., 2019). This collaborative model ensures that tourism benefits are equitably shared, while conservation efforts receive broad support from the local population.

3.2.4. Economic and environmental impacts

The economic impact of ecotourism in Pu Luong has been significant, providing local communities with a steady income stream while reducing their dependence on environmentally damaging practices such as logging and slash-and-burn agriculture (Nguyen & Hoang, 2020). This shift has contributed to forest regeneration and biodiversity conservation, as pressure on the forest has decreased.

Additionally, the emphasis on conservation has helped maintain the ecological integrity of the reserve, ensuring that it remains a viable habitat for endangered species. The presence of well-managed tourism has also raised awareness about the importance of conservation, both among local residents and visitors, contributing to a culture of environmental stewardship (Tran & Vo, 2022).

3.2.5. Challenges faced and sustainability measures

Despite its successes, Pu Luong faces challenges associated with managing the increasing number of visitors. If not properly managed, tourism growth can lead to environmental degradation, particularly in terms of waste management and infrastructure (Le & Pham, 2021). To address these challenges, the reserve has implemented sustainability measures, including limiting the number of visitors to sensitive areas, promoting off-season tourism, and investing in conservation projects (Pham et al., 2019). These measures are crucial for ensuring that Pu Luong continues to serve as a model for sustainable tourism in Vietnam, protecting its natural beauty while supporting local communities.

3.3. Case Study 3: Mekong Delta Homestays – Promoting Cultural & Environmental Sustainability

3.3.1. Background and overview

The Mekong Delta, known as the "rice bowl" of Vietnam, is a region characterized by its vast network of rivers, swamps, and islands. The delta is not only crucial for Vietnam’s agriculture but also a popular destination for tourists seeking authentic rural experiences. In recent years, homestays in the Mekong Delta have become a popular form of accommodation, offering tourists an opportunity to live with local families and experience the traditional way of life. These homestays have emerged as an important component of sustainable tourism in the region.

3.3.2. Role of homestays in preserving local culture

Homestays in the Mekong Delta play a vital role in preserving the region’s cultural heritage. By staying with local families, tourists gain a deeper understanding of the customs, traditions, and daily life of the people in the delta. This form of tourism helps to keep cultural practices alive, as hosts often involve guests in activities such as cooking traditional meals, participating in local festivals, and learning about local crafts.

Moreover, the revenue generated from homestays provides an incentive for families to maintain their traditional lifestyles rather than shifting to more commercialized forms of tourism. This helps to preserve the unique cultural identity of the Mekong Delta, which is a key attraction for visitors.

3.3.3. Environmental sustainability practices

Environmental sustainability is also a key focus of homestay tourism in the Mekong Delta. Many homestays are built using locally sourced materials, such as bamboo and palm leaves, which have a lower environmental impact compared to modern construction materials. Additionally, homestay owners are encouraged to implement eco-friendly practices, such as waste reduction, water conservation, and the use of renewable energy sources.

Some homestays also participate in local environmental initiatives, such as reforestation projects and the protection of mangrove forests, which are crucial for maintaining the delta’s ecological balance. These efforts not only help to protect the environment but also enhance the appeal of the homestays to eco-conscious travelers.

3.3.4. Economic benefits for local communities

The economic benefits of homestay tourism in the Mekong Delta are significant. For many families, hosting tourists provides a much-needed source of income that can be used to improve living standards, pay for education, and invest in the maintenance of their homes. This income diversification is particularly important in the delta, where agriculture is becoming increasingly vulnerable to climate change and other environmental pressures.

Moreover, homestay tourism creates employment opportunities for other members of the community, such as guides, drivers, and artisans, further spreading the economic benefits of tourism. By keeping the economic benefits within the local community, homestay tourism helps to ensure that tourism development is inclusive and sustainable.

3.3.5. Challenges and future prospects

Despite its many benefits, homestay tourism in the Mekong Delta faces several challenges. One of the main challenges is maintaining the authenticity of the homestay experience as tourism demand grows. There is a risk that homestays could become commercialized, losing the personal touch and cultural richness that make them unique. To address this challenge, it is important to implement standards and guidelines that ensure the quality and authenticity of the homestay experience. Additionally, marketing efforts should focus on attracting tourists who are genuinely interested in cultural and environmental sustainability, rather than those seeking a more commercialized experience. Looking to the future, the prospects for homestay tourism in the Mekong Delta are promising. With continued investment in infrastructure, training, and marketing, homestay tourism has the potential to become a leading example of sustainable tourism in Vietnam, providing economic, cultural, and environmental benefits for the region.

3.4. Case Study 4: Marine Protected Areas – Con Dao Islands

3.4.1. Background and overview

The Con Dao Islands, located off the southeastern coast of Vietnam, consist of 16 islands known for their pristine beaches, coral reefs, and rich marine biodiversity (Nguyen, 2021). The islands have been designated as a Marine Protected Area (MPA) to conserve their unique marine ecosystems and protect endangered species such as sea turtles and dugongs (Vo & Le, 2019). Sustainable tourism has been identified as a key strategy for achieving these conservation goals while supporting the livelihoods of local communities (Pham et al., 2020).

3.4.2. Marine conservation efforts and sustainable tourism

The Con Dao MPA, established in 1993, spans 20,000 hectares of marine and terrestrial ecosystems (Tran & Nguyen, 2021). The MPA aims to protect the islands' coral reefs, seagrass beds, and marine species from overfishing, pollution, and other environmental threats. Sustainable tourism is employed as a complementary conservation tool, providing an alternative source of income for local communities while raising awareness about marine conservation (Nguyen & Vu, 2022). Tourism activities, such as diving and snorkeling, are carefully managed to minimize environmental impact. Strict guidelines are followed to protect coral reefs, and visitors are educated on marine conservation practices. Programs like beach clean-ups and sea turtle conservation activities actively involve tourists in preservation efforts (Vo & Le, 2019). These initiatives promote a deeper understanding of conservation challenges among visitors and enhance the ecological integrity of the MPA.

3.4.3. Role of local and national governments

The success of sustainable tourism in Con Dao is largely attributed to collaboration between local and national government entities. The Con Dao MPA is co-managed by local authorities, the Ministry of Agriculture and Rural Development, and the Vietnam Administration of Seas and Islands (Pham et al., 2020). These agencies cooperate to enforce regulations, conduct marine research, and promote sustainable tourism practices. Government support has played a vital role in developing infrastructure for sustainable tourism, such as waste management systems and eco-friendly accommodations (Nguyen & Vu, 2022). Policies incentivizing sustainable tourism, such as tax breaks for businesses adhering to environmental standards, have further encouraged eco-friendly tourism development on the islands (Tran & Nguyen, 2021).

3.4.4. Impact on marine biodiversity and local livelihoods

Sustainable tourism has had a largely positive impact on marine biodiversity in Con Dao. Conservation efforts, such as the protection of coral reefs and seagrass beds, have led to the recovery of fish populations and other marine species (Nguyen, 2021). Notably, the sea turtle conservation program has been highly successful, with increased nesting activity, making it a significant draw for eco-tourists (Vo & Le, 2019). Economically, sustainable tourism has provided alternative livelihoods for the local population, reducing reliance on fishing and alleviating pressure on marine resources (Pham et al., 2020). Many locals now engage in eco-tourism activities, including guiding tours, operating guesthouses, and selling local handicrafts, contributing to both economic development and marine conservation (Nguyen & Vu, 2022).

3.4.5. Challenges and strategies for sustainable management

Despite its successes, the Con Dao Islands face challenges related to managing increasing visitor numbers. Overcrowding, waste management, and potential environmental degradation are ongoing concerns (Tran & Nguyen, 2021). To address these issues, MPA management has implemented measures such as limiting visitor numbers during peak seasons, promoting off-peak tourism, and investing in sustainable infrastructure (Nguyen & Vu, 2022). Ongoing monitoring and research are essential for adapting management strategies to changing environmental conditions. These efforts are crucial for maintaining the ecological balance of the MPA and ensuring the long-term sustainability of tourism on the islands (Pham et al., 2020). In summary, the Con Dao Islands exemplify how marine conservation and sustainable tourism can be effectively integrated to protect natural resources while benefiting local communities. Continued efforts to manage tourism sustainably are vital to preserving the islands' unique marine ecosystems for future generations.

3.5. Case Study 5: Hoi An – Heritage Conservation and Sustainable Urban Tourism

3.5.1. Background and overview

Hoi An, a UNESCO World Heritage site in central Vietnam, is celebrated for its well-preserved ancient town, which showcases a unique fusion of Vietnamese, Chinese, Japanese, and European architectural styles (Nguyen & Pham, 2020). As one of Vietnam's top tourist attractions, Hoi An has encountered significant challenges in balancing tourism development with heritage conservation. Sustainable urban tourism has become an essential strategy for preserving the town's cultural legacy while managing the rising influx of visitors (Truong et al., 2021).

3.5.2. Integration of heritage conservation and tourism

The preservation of Hoi An's cultural heritage is a cornerstone of its tourism development approach. Historic structures, including temples, pagodas, and homes, have been carefully restored and maintained, ensuring new developments align with the traditional aesthetic (Hoang, 2022). In collaboration with UNESCO and other international bodies, the local government has created heritage conservation guidelines for all tourism-related projects (UNESCO, 2019). Tourism in Hoi An is managed to minimize the impact on the town's cultural assets. For example, visitor numbers to heritage sites are capped, and small group tours are encouraged to limit physical wear on buildings. Additionally, revenue from tourism is reinvested in conservation projects, ensuring the protection of Hoi An’s cultural heritage for future generations (Nguyen & Pham, 2020).

3.5.3. Sustainable urban tourism practices

Beyond heritage preservation, Hoi An has adopted a variety of sustainable urban tourism practices aimed at reducing environmental harm. The town has implemented a comprehensive waste management system, including recycling initiatives and efforts to reduce plastic consumption (Truong et al., 2021). Public transport solutions such as bicycles and electric buses are promoted to alleviate traffic and reduce air pollution (Hoang, 2022).

Hoi An has also embraced the concept of "slow tourism," encouraging visitors to spend more time exploring the town and its surroundings at a relaxed pace. This approach not only improves the tourist experience but also spreads visitor numbers more evenly, reducing pressure on the town's infrastructure (UNESCO, 2019).

3.5.4. Community engagement and economic impact

The active involvement of the local community has been key to the success of sustainable tourism in Hoi An. Locals participate in tourism by running homestays, offering cooking classes, and selling handicrafts, ensuring the economic benefits of tourism are shared across the community (Truong et al., 2021). Tourism has significantly boosted Hoi An's economy, becoming a major income source for residents. However, the local government has carefully managed tourism growth to avoid compromising the town's cultural identity. By promoting sustainable practices, Hoi An has maintained its reputation as a leading cultural destination while preserving its heritage (Nguyen & Pham, 2020).

3.5.5. Challenges and future directions

Despite its success, Hoi An faces challenges due to rising tourist numbers, particularly during peak seasons. Overcrowding and the commercialization of certain areas risk diminishing the town’s cultural heritage and visitor experience (Hoang, 2022). To address these challenges, the local government is exploring strategies such as promoting tourism in less-visited parts of the town, improving infrastructure to accommodate tourist growth, and enhancing visitor management systems (Nguyen & Pham, 2020). There is also a growing emphasis on diversifying tourism offerings by promoting ecotourism and rural tourism in the surrounding areas, reducing pressure on the ancient town (Truong et al., 2021). In conclusion, Hoi An serves as an exemplary model of how sustainable urban tourism can be achieved through a combination of heritage conservation, community engagement, and environmental management. By continuing to innovate and adapt, Hoi An can preserve its status as a world-renowned cultural destination while ensuring the long-term sustainability of its tourism industry.

4. Discussion

4.1. Common themes and strategies across the case studies

The case studies of Sapa O’Chau, Pu Luong Nature Reserve, Mekong Delta Homestays, Con Dao Islands, and Hoi An highlight several common themes in sustainable tourism practices in Vietnam. One of the most prominent themes is the emphasis on community involvement in tourism management. Across these initiatives, local communities are central to managing tourism activities, ensuring that tourism benefits are equitably distributed and that local customs and traditions are preserved (Nguyen & Le, 2020). This approach empowers communities, providing them with a sense of ownership and ensuring that tourism enhances rather than undermines local livelihoods.

Another key strategy is the integration of environmental conservation with tourism development. The case studies demonstrate a holistic approach, where economic, social, and environmental goals are balanced. For example, Pu Luong Nature Reserve emphasizes ecotourism to preserve biodiversity, while the Con Dao Islands combine marine conservation with sustainable tourism to protect critical ecosystems (Pham et al., 2021). In Hoi An, urban tourism management is linked with waste reduction and recycling efforts, ensuring that tourism growth does not harm the environment (Truong & Hoang, 2019).

4.2. Differences in approaches and outcomes

While common themes are present, there are notable differences in the approaches and outcomes of these sustainable tourism initiatives. Sapa O’Chau focuses heavily on cultural preservation and community empowerment, engaging ethnic minority groups in tourism management and showcasing traditional practices (Nguyen & Le, 2020). In contrast, the Con Dao Islands prioritize marine conservation, with sustainable tourism being a means to support biodiversity protection, particularly for endangered species such as sea turtles and dugongs (Pham et al., 2021). Hoi An's sustainable tourism model focuses on urban heritage conservation, integrating tourism with the preservation of historic architecture and cultural assets in a rapidly urbanizing environment (Truong & Hoang, 2019). This urban-focused model presents unique challenges, such as managing the influx of tourists while maintaining the integrity of heritage sites, which differs from the rural and nature-based focus seen in Pu Luong and Con Dao.

4.3. Factors contributing to success or challenges

Several factors have contributed to the successes or challenges faced by these sustainable tourism initiatives. One of the critical success factors is strong collaboration between local communities, government bodies, and international organizations. For instance, in Hoi An and Con Dao, such partnerships have been vital in crafting effective tourism management strategies and implementing conservation measures (Truong & Hoang, 2019; Pham et al., 2021). Another factor is the management of environmental impacts. Initiatives like Pu Luong and Con Dao have successfully balanced environmental conservation with tourism, maintaining ecological integrity while promoting tourism development. For example, Pu Luong's reforestation efforts and Con Dao's marine monitoring programs have been crucial in preserving biodiversity (Nguyen et al., 2021).

However, these initiatives also face significant challenges. Managing visitor numbers, particularly in areas like Hoi An, is essential to prevent overcrowding and maintain the quality of tourist experiences. Additionally, ensuring the equitable distribution of tourism benefits remains a critical challenge, as some regions may struggle with ensuring that the economic gains from tourism reach all community members (Pham et al., 2021).

4.4. Insights into sustainable tourism practices in Vietnam

The case studies provide valuable insights into sustainable tourism practices in Vietnam. They demonstrate that involving local communities in tourism management, promoting environmentally friendly tourism practices, and aligning tourism development with conservation objectives are essential strategies for achieving sustainability (Nguyen & Le, 2020). These initiatives show that sustainable tourism not only preserves the environment but also supports local communities economically, making it a viable model for other regions in Vietnam and beyond.

Furthermore, the case studies highlight the need for continuous adaptation and learning. As the tourism industry evolves, so must the strategies that underpin sustainable tourism. By leveraging the successes of these initiatives and learning from their challenges, Vietnam can continue to develop a tourism industry that supports long-term environmental sustainability and resilience (Truong & Hoang, 2019).

5. Conclusion

This paper has explored various case studies of sustainable tourism initiatives in Vietnam, highlighting the strategies, successes, and challenges of these efforts. Key findings include the importance of community involvement in tourism management, the integration of environmental conservation with tourism development, and the need for continuous learning and adaptation. The case studies demonstrate that sustainable tourism can provide significant benefits for both the environment and local communities, but also that it requires careful planning and management to address challenges such as visitor management, cultural authenticity, and equitable distribution of benefits. The success of sustainable tourism initiatives in Vietnam underscores the importance of continued efforts to promote and support sustainable tourism development. As the tourism industry continues to grow, it is essential to ensure that this growth is managed in a way that protects the country's natural and cultural heritage, supports local communities, and contributes to long-term sustainability. By continuing to invest in sustainable tourism practices, Vietnam can strengthen its position as a leader in sustainable tourism and ensure that its tourism industry remains a vital contributor to the country's economic and social development. Looking ahead, the future of tourism in Vietnam will be shaped by the ability of the industry to adapt to changing conditions and to balance the needs of tourists, local communities, and the environment. The case studies presented in this paper provide valuable insights into how sustainable tourism can be achieved and offer a roadmap for future development. By building on these successes and addressing the challenges that remain, Vietnam can continue to develop its tourism industry in a way that is sustainable, resilient, and inclusive, ensuring that it benefits both current and future generations.

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Taiwan's Experience in Sustainable Industrial Development and Implications for Vietnam

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Abstract

This paper explores Taiwan's approach to sustainable industrial development and its potential relevance for Vietnam. It begins with an overview of Taiwan's successes, particularly in integrating green industries and renewable energy. The paper then examines Vietnam's industrial development, highlighting both achievements and limitations. Key similarities between Taiwan and Vietnam's industrial trajectories are discussed, leading to implications for how Vietnam can adopt and adapt strategies from Taiwan to enhance its sustainable industrial growth. The study underscores the importance of government policy, innovation, and international collaboration in achieving these goals.

Keywords: *environmental protection, industrial development, Taiwan, Vietnam.*

1. Introduction

As the world increasingly confronts the realities of climate change and environmental degradation, the need for sustainable industrial development has become more pressing. Taiwan, recognized for its rapid industrialization and technological advancements, offers valuable insights into integrating sustainability into industrial growth. Between the 1960s and 1990s, Taiwan's transformation into one of Asia's economic "Tigers" was marked by significant achievements in technology and industrialization. Today, it stands as a model for sustainable industrial development, particularly through its advancements in green industries and renewable energy.

This paper explores Taiwan's successful strategies in sustainable industrial development and examines their applicability to Vietnam. Taiwan's experience provides a pertinent case study, illustrating how policy interventions, technological innovation, and international cooperation can drive industrial growth while addressing environmental and social challenges. Key to Taiwan's success has been its ability to integrate green practices within its industrial sector, advancing not only its economic growth but also its environmental stewardship.

In contrast, Vietnam's industrial sector, while growing rapidly, faces challenges in balancing economic development with environmental sustainability. The Vietnamese government has recognized the importance of green industrial practices but must navigate several hurdles, including infrastructure limitations, technological gaps, and the need for effective policy frameworks. By comparing Taiwan's experiences with Vietnam's current industrial landscape, this paper aims to identify actionable strategies and recommendations for Vietnam's pursuit of sustainable development.

The study employs a qualitative approach, reviewing literature and policy documents to highlight the similarities and differences between the two economies. It underscores the critical role of government policies, stakeholder engagement, and technological advancements in fostering a green industrial transition. The findings offer valuable implications for Vietnam, suggesting ways to adapt Taiwan's successful strategies to the nation context and enhance its sustainable development efforts. This exploration aims to support Vietnam in achieving its sustainability goals and advancing its industrial sector in an environmentally responsible manner.

2. Literature review

Many researchers have increasingly focused on Taiwan's experience in sustainable industrial development, recognizing its valuable insights for shaping Vietnam's industrial strategies.

The book "Industry 3.5 - Taiwan's Experience and Vietnam's Approach" by Dr. Ha Minh Hiep and Professor Chen-Fu Chien (2021) offers a comprehensive analysis of Taiwan's strategic shift towards Industry 3.5 as a more suitable alternative to Industry 4.0, considering its unique industrial structure and socio-economic context. The authors explore how Industry 3.5, characterized by the collaboration between humans and intelligent machines, serves as a transitional strategy combining elements of both Industry 3.0 and 4.0. This approach is particularly relevant for Taiwan, given its industrial foundation, the dominance of small and medium-sized enterprises (SMEs), and the potential social challenges posed by fully automated production systems. The book is structured into four parts with 14 chapters, detailing the core concepts of Industry 3.5, its strategic advantages, and its implications for Taiwan's industrial transformation. Furthermore, it provides valuable insights for Vietnam’s journey towards smart manufacturing, highlighting strategic orientations and practical frameworks for successful implementation. This work is an essential resource for policymakers, industry leaders, and researchers aiming to understand and leverage Taiwan's industrial experience to foster sustainable economic growth and technological advancement in Vietnam.

In the context of Vietnam's pursuit of sustainable development, the concept of a circular economy is increasingly gaining attention, especially as the country faces mounting challenges such as resource depletion, environmental pollution, and climate change. The experience of Taiwan, which has successfully implemented a circular economy model across six core industries, offers valuable lessons for Vietnam. According to Tran Long (2023), Taiwan's strategic emphasis on these industries—ranging from Green and renewable energy to high-tech medical industries- under the 5+2 Industrial Innovation Program has positioned the island nation to leverage opportunities in the post-pandemic era. This model highlights the importance of leadership awareness and international cooperation in transitioning towards a circular economy, which is crucial for Vietnam's sustainable economic recovery and resilience.

The article by Vu Nhat Quang and Vu Thi Que Anh (2022), titled *"Developing Renewable Energy in Vietnam: Lessons from Taiwan"* provides a comprehensive analysis of Taiwan's renewable energy development strategies and offers valuable lessons for Vietnam. The authors emphasize the urgency of transitioning to renewable energy sources in the context of depleting traditional energy reserves, highlighting Taiwan's strategic policies, such as the Renewable Energy Development Act (REDA) and economic incentives, which have significantly boosted the country's renewable energy sector. The article suggests that Vietnam can draw critical lessons from Taiwan, including the necessity of clear legislative frameworks, the promotion of scientific research, and the encouragement of private sector investment to accelerate its renewable energy development.

The article by Vo Hai Thanh discusses Taiwan's strategic approach to advancing the Fourth Industrial Revolution, highlighting the context, vision, goals, and key policies that the Taiwanese government has implemented under its "Productivity 4.0" initiative. This strategy, which builds on the global concept of Industry 4.0, focuses on enhancing industrial transformation across various sectors, including agriculture, textiles, electronics, and healthcare, with a strong emphasis on smart manufacturing and technological innovation. The article provides valuable insights and lessons for emerging economies like Vietnam, particularly in terms of developing a comprehensive strategy for science, technology, and innovation, fostering public-private partnerships, and enhancing human resources to stay competitive in the global landscape.

The article by Du Lam (2021) offers a comprehensive analysis of Taiwan's transformation into a high-tech manufacturing powerhouse, emphasizing the island's strategic shift from an agrarian economy to an industrial and technological hub after World War II. The piece details the gradual evolution of Taiwan's electronics and semiconductor industries, highlighting key milestones such as the establishment of TSMC and the development of DRAM technology. The article also draws parallels between Taiwan's experience and Vietnam's current "Make in Vietnam" strategy, suggesting that technological innovation and industrial modernization are critical pathways for emerging economies to achieve sustainable growth and global competitiveness (Du Lam, 2021).

These studies collectively underscore the importance of Taiwan's industrial policies and innovations as a model for Vietnam's pursuit of sustainable economic growth

3. Research methods

The research draws on a collection of data sourced from the General Statistics Office, Ministry of Planning and Investment, Ministry of Natural Resources and Environment, along with insights from international organizations such as the United Nations Industrial Development Organization (UNIDO) and the World Intellectual Property Organization (WIPO). The study employs a qualitative approach, focusing on Taiwan's experiences in sustainable industrial development and examining both achievements and challenges within Vietnam's industrial sector.

Through review of existing literature and policy documents, the study identifies key similarities and differences between Taiwan's and Vietnam's industrial development trajectories. This analysis provides valuable implications for Vietnam's strategies in pursuing sustainable industrial development.

4. Results

4.1. Taiwan's successes in sustainable industrial development

Taiwan's industrial development is a testament to strategic planning and adaptability, positioning it as a significant player in the global economy.

Firstly, Taiwan's industrial journey began under Japanese colonial rule in the late 19th century, which laid the initial groundwork for industrialization. The pace of industrialization increased during World War I and further accelerated during World War II, establishing a base for heavy industries that contributed significantly to the island's economic growth (Copper, 2024).

Secondly, the post-war period saw a remarkable transformation in Taiwan's manufacturing sector. Starting in the late 1950s, Taiwan's annual industrial growth rate averaged about 12 percent, a pace that quickened even further during the 1960s and '70s. This period of rapid growth outpaced the industrialization rates of the UK and Japan during their peak periods. Initially, Taiwan focused on light industries such as textiles and small appliances. Over time, the focus shifted to more labor-intensive and capital-intensive industries, including electronics and ICT products (Copper, 2024).

Thirdly, the strategic development of Taiwan's semiconductor industry has been a cornerstone of its industrial success. In 1964, Taiwan established its first semiconductor laboratory, and by 1974, ERSO had acquired CMOS technology from RCA. This pivotal acquisition enabled Taiwan to enter the global semiconductor industry. The founding of TSMC in 1987 further propelled the industry, spurring the growth of the IC design sector and establishing Taiwan as a leading center for IC manufacturing. Companies like TSMC, Foxconn, Acer, and Asus have become major players in the global technology market, significantly contributing to Taiwan's competitive position (Copper, 2024).

Fourthly, Taiwan's economy has shown robust growth, with GDP rising from $512.96 billion in 2013 to $755.31 billion in 2023, maintaining an average annual growth rate of 3.1 percent between 2013 and 2023 (Textor, 2024). The industrial sector has played a crucial role in this growth, contributing approximately 36.8 percent to Taiwan's GDP in 2023, with the manufacturing sector accounting for about 38 percent and providing jobs to 35 percent of the workforce (asiafundmanagers.com). Taiwan remains a global leader in semiconductor production and other electronic products, integral to its position in global value chains.

Additionally, Taiwan's strategic initiatives, such as the New Model for Economic Development adopted in 2016 and the National Development Plan (2021-2024), have focused on fostering knowledge-based and innovative technologies. These initiatives prioritize information and digital technology, cybersecurity, medical technology, green energy, and national defense, ensuring sustained economic progress and competitiveness (Bajpai, 2022).

Moreover, the well-developed science and research sector, exemplified by the ITRI Industrial Technology Research Institute, has been instrumental in driving Taiwan's industrial innovation. ITRI has not only conducted industry-oriented research but has also spawned several spin-offs, including TSMC, which have grown into billion-dollar corporations over the years, contributing to Taiwan's economic diversification and future competitiveness (Hempen and Blechert, 2020).

Lastly, Taiwan's achievements in sustainable industrial development are reflected in its Environmental Performance Index (EPI) 2024 scores. Ranking 59th globally with an overall EPI score of 50.3, Taiwan has made a modest improvement over the past decade (EPI 2024). In air pollution control, Taiwan ranks 41st with a high score of 86.5, though it experienced a slight decline of 3.3 points, indicating effective yet continuously challenged air quality management efforts. Taiwan's water resources management, ranking 87th with a score of 39.2, has remained stable over the past decade, highlighting an area that requires further attention. Environmental health saw significant progress, with Taiwan ranking 68th and improving its score by 4.5 points to 50.0, reflecting advancements in public health and environmental safety measures. Despite ranking 49th in climate change with a score of 48.4 and a slight decline of 1.0, Taiwan's focus on mitigating climate impacts remains crucial. These indicators underscore Taiwan's ongoing commitment to integrating environmental sustainability within its industrial development framework (EPI 2024).

Table 1: Environmental Performance Index of Taiwan and Viet Nam

Indicator	Taiwan Rank	Taiwan Score	Taiwan 10y Δ	Vietnam Rank	Vietnam Score	Vietnam 10y Δ
Environmental Performance Index	59	50.3	0.3	180	24.5	-4.6
Air Pollution	41	86.5	-3.3	180	7.5	-34.8
Water Resources	87	39.2	0.0	136	14.9	0.0
Environmental Health	68	50.0	4.5	142	26.6	3.1
Climate Change	49	48.4	-1.0	175	17.9	-9.4

Source: Environmental Performance Index 2024

Thus, Taiwan's competitive position on the global stage has consistently been strong, as evidenced by its ranking in the Global Competitiveness Report and the IMD World Competitiveness Yearbook. In 2018, Taiwan was ranked 13th out of 140 economies, recognized as an "innovation powerhouse" and ranked 4th in the Asia-Pacific region, just behind Singapore, Japan, and Hong Kong. By 2024, despite a slight decline to 8th place in the IMD World Competitiveness Yearbook, Taiwan's performance remains impressive, outperforming major economies like the United States, China, Japan, and South Korea. This decline is primarily attributed to a global demand slowdown that significantly impacted Taiwan's manufacturing sector, leading to a drop in its "Economic Performance" index. However, Taiwan's continued strength in "Business Efficiency," where it ranks 6th globally, underscores its robust industrial capabilities and adaptability, highlighting its resilience in maintaining a strong competitive edge despite external challenges. This resilience is crucial for Taiwan as it navigates a complex global economic environment, ensuring sustained economic growth and industrial development.

Table 2: Competitiveness of Taiwan

2020	2021	2022	2023	2024
11	8	7	6	8

Source: Institute for Management Development 2024

4.2. Achievements and limitations of Industrial Development in Vietnam

Firstly, Vietnam's industrial sector demonstrated resilience in 2023, with 63.6% of second-tier industries experiencing growth. The General Statistics Office reported a 3.02% increase in the added value of the entire industry compared to 2022, though this growth rate was modest compared to previous years. The processing and manufacturing sector remained a key driver, with a 3.48% increase contributing significantly to economic recovery.

Secondly, the expansion of industrial park infrastructure was notable, with 13 new projects approved, increasing the total to 416 industrial parks, and creating over 4.15 million jobs by the end of 2023 (General Statistics Office, 2024).

However, the industrial production index (IIP) growth rate in 2023 was the lowest in 12 years at 1.5%, partly due to declining outputs in the mining sector (General Statistics Office, 2024). Additionally, serious environmental issues, including air pollution from industrial activities, have negatively impacted public health and socio-economic development. Vietnam's ecological sustainability remains a concern, as highlighted by the Global Innovation Index 2023, where the country ranked low at 110 for ecological sustainability. The transformation towards greener industrial practices is challenging and requires significant time and financial resources. Furthermore, inadequate integration of economic development and environmental protection, coupled with poor management and coordination among various sectors, exacerbates these challenges (WIPO, 2023).

Table 3: Innovation and Creativity Index of Vietnam 2017 – 2023

2017	2018	2019	2020	2021	2022	2023
47	45	42	42	44	48	46

Source: WIPO 2023

4. Discussion and Conclusion

4.1. Similarities in industrial development between Taiwan and Vietnam

Firstly, Taiwan and Vietnam have experienced significant transformations from agrarian economies to industrial powerhouses. In the early stages of their development, both economies faced considerable economic challenges, including underdeveloped industrial sectors, widespread unemployment, and low living standards. Taiwan's initial economic condition after World War II was marked by a reliance on agriculture, with a relatively underdeveloped industrial base. Similarly, Vietnam, in its early years after reunification, faced the task of rebuilding its economy, which was predominantly agrarian with outdated industrial infrastructure.

Secondly, both economies implemented strategic industrial policies that prioritized manufacturing and technological advancement. Taiwan, through targeted policies, transformed itself into a leader in high-tech industries, particularly in semiconductors and electronics. Taiwan actively promoted industrial parks and export processing zones, which became hubs for technological innovation and industrial growth. Vietnam, recognizing the need to modernize its economy, has followed a similar trajectory by focusing on industrialization and modernization, particularly in high-tech sectors. The Vietnamese government has implemented policies to attract FDI, particularly from technology-driven economies like Taiwan, and has promoted the development of industrial zones to support these sectors.

Thirdly, Taiwan's expertise in high-tech industries, such as semiconductors and electronics, presents a model for Vietnam, which is increasingly focusing on developing its own high-tech industrial sector. Taiwanese companies have established a strong presence in Vietnam, transferring technology and expertise that have significantly contributed to the growth of Vietnam’s high-tech industries. As a result, Vietnam is emerging as an important player in the global supply chain, particularly in electronics manufacturing, with ambitions to further expand its role in high-tech sectors, including semiconductor production.

Fourthly, the cultural similarities between Taiwan and Vietnam, including shared Confucian values, have facilitated smoother communication and collaboration in business and investment. This cultural affinity reduces barriers to cooperation and enhances mutual understanding, which is critical in forging strong economic partnerships. Taiwanese investors often find Vietnam’s cultural and business environment familiar and conducive to investment, which has led to increased FDI inflows from Taiwan into Vietnam’s industrial sectors.

Fifthly, the ongoing shift in global supply chains, driven by factors such as trade tensions and the need for more resilient supply networks, has positioned Vietnam as a strategic destination for Taiwanese investment. Vietnam’s strategic location, competitive labor costs, and comprehensive free trade agreements make it an attractive alternative for Taiwanese companies looking to diversify their production bases. This trend is expected to continue, with Vietnam increasingly becoming a key node in the global supply chain for high-tech products, a role that Taiwan has historically played.

Thus, Taiwan has become a significant investor in Vietnam, particularly in sectors where Taiwanese businesses have strong competitive advantages, such as electronics, high-tech industries, manufacturing, supporting industries, renewable energy, and high-quality agriculture. These areas align with Vietnam's strategic development priorities, making Taiwan a crucial partner in its industrial and economic growth. In 2023, Taiwanese investment in Vietnam reached $2.2 billion, marking a remarkable fourfold increase compared to 2022. This surge underscores the deepening economic ties between the two regions. Cumulatively, Taiwan ranks 4th among 105 economies and territories investing in Vietnam, with nearly 3,200 projects and over $39.5 billion in registered capital. Taiwan has also become Vietnam's 5th largest trading partner, reflecting the growing importance of their economic relationship. Despite fluctuations in global markets, Taiwan's consistent investment flow into Vietnam highlights the resilience and strategic alignment between the two economies. As of 2023, Taiwan's cumulative FDI in Vietnam stands at $39.4 billion, securing its position as one of the top FDI contributors and reinforcing its role in Vietnam's economic development.

Table 4: Foreign direct investment projects licensed by main counterparts

(Accumulation of projects having effect as of 31/12/2023)

	Number of projects	Total registered capital (Mill. USD)
Total	39151	470170,3
- Of which:		
Korea Rep.of	9859	86510,5
Singapore	3498	74901,8
Japan	5263	73887,7
Taiwan	**3109**	**39362,3**
Hong Kong SAR (China)	2465	34190,2
China, PR	4249	27130,1

Source: General Statistics Office 2024

4.2. Implications for Vietnam in sustainable industrial development

Tailor green industrial policies to local conditions

Vietnam should develop green industrial policies that are closely aligned with the country's unique resources, infrastructure, technology standards, and business ecosystems. The successful greening of industries requires a deep understanding of local conditions to identify sectors where green practices can be most effectively implemented. By focusing on industries where existing capabilities can support a green transition, Vietnam can create a strong foundation for sustainable industrial growth.

Strengthen governmental leadership and policy framework

The Vietnamese government must take a proactive role in driving the green transition by developing a robust policy framework. This includes setting clear, measurable objectives and establishing indicators for progress. Like Taiwan, Vietnam should focus on crafting policies that guide industries through structured phases of greening, with regular assessments to evaluate the effectiveness of these policies and adjust strategies as necessary.

Foster collaboration between research institutions and industry

Promoting collaboration between research institutions, private enterprises, and government agencies is essential for aligning industrial development goals with sustainable practices. Vietnam should encourage partnerships that leverage scientific research and industrial expertise, facilitating the development of green technologies and innovations that are both practical and scalable.

Create a competitive environment to drive innovation

Vietnam should foster a competitive environment that encourages continuous innovation in green technologies and practices. The government can stimulate this by offering incentives to companies that invest in green R&D and adopt sustainable production methods. By promoting competition, Vietnam can ensure that its industries remain at the forefront of green innovation, similar to how Taiwan has maintained its competitive edge.

Enhance public awareness and engagement

Public awareness and engagement are critical to the success of sustainable industrial development. Vietnam should intensify efforts to educate the public about the benefits of green growth and the importance of environmental stewardship. This can be achieved through nationwide campaigns that emphasize the economic and environmental advantages of green practices. Additionally, the government should create platforms for public participation in green initiatives, ensuring that all societal levels contribute to and benefit from the green transition.

Support domestic enterprises in green transformation

The Vietnamese government should implement policies that support domestic enterprises in adopting green technologies and practices. This includes providing financial incentives, technical assistance, and access to international markets. By helping domestic firms integrate into global green supply chains, Vietnam can enhance its industrial competitiveness and attract more foreign direct investment, particularly in high-tech and environmentally sustainable sectors.

Leverage international cooperation and investment

Vietnam should actively seek international cooperation and investment to accelerate its green industrial development. Learning from Taiwan's experience, Vietnam can establish partnerships with global leaders in green technology, facilitating the transfer of knowledge and expertise. This will not only enhance Vietnam's technological capabilities but also position the country as a key player in the global green economy.

5. Conclusion

In conclusion, Taiwan's journey towards sustainable industrial development offers valuable lessons for Vietnam as it seeks to balance economic growth with environmental sustainability. Taiwan’s success in transforming its industrial sector through strategic policies, innovation, and strong government leadership demonstrates the importance of a holistic approach that integrates environmental considerations into economic planning. For Vietnam, adopting similar strategies -tailored to its unique conditions - can accelerate its green transformation, positioning the country as a regional leader in sustainable development. By learning from Taiwan’s experiences and fostering international cooperation, Vietnam can effectively navigate the challenges of industrialization while contributing to global efforts in combating climate change.

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The Development of Hanoi's Industry: Current Situation and Solutions

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Abstract

This study analyzes the industrial development situation in Hanoi focusing on the period 2014-2023. Based on secondary data collected from prestigious organizations, the author used statistical methods of description and comparison to analyze and evaluate achievements, limitations, and causes of restrictions in the industrial development of the city of Hanoi. The results show that, despite significant progress, industrial development in Hanoi still faces many social and environmental challenges. The research proposes solutions for sustainable industrial development in Hanoi by 2025 and towards 2030, including: developing leading industry groups; promoting green industries; building eco-industrial parks; raising community awareness and accountability; and strengthening international cooperation.

Keywords: *industrial development; sustainable industrial development; Hanoi City*.

1. Introduction

According to the General Statistics Office, the Gross Regional Domestic Product (GRDP) of Hanoi in 2022 at current prices reached 1,196 trillion VND, accounting for 13% of the country's GDP. The industrial production value of Hanoi in 2022 at current prices accounted for 15.95% of the total regional product, which is lower than Ho Chi Minh City (18.1%) and Quang Ninh Province (45%). Furthermore, Hanoi is frequently ranked among the most polluted cities in the world; the air quality index and fine dust index are particularly poor, especially during the dry season (https://www.iqair.com/). Therefore, the development of industries while preserving the environment and effectively addressing social issues has become increasingly urgent.

The main issue this study aims to address is how to sustainably develop industries in Hanoi, ensuring economic growth without harming society and the environment. Based on a summary of several exemplary studies, the author presents the research methodology, evaluates the achievements and limitations, along with their causes, and proposes some solutions and recommendations for sustainable industrial development in the capital city until 2025, with an orientation toward 2030.

Research on sustainable industrial development in Hanoi is significant not only in terms of theory but also in practical value. Theoretically, this study will contribute to the body of research on industrial development in the context of rapid urbanization and increasing environmental challenges. Practically, the research results will provide feasible solutions to balance economic growth and environmental protection, contributing to the sustainable development of the capital.

2. Literature review

Industrial development is a topic of interest to many researchers around the world. Recent studies can be divided into two main groups:

First, the studies focused on national industrial development strategies and policies, including the establishment and development of industrial ecosystems at the national level.

Second, the studies on local industrial development. This group of research indicates that to sustainably develop local industries, it is necessary to base them on the foundation of macro-level strategies and policies. At the same time, each region and locality must consider specific characteristics to develop action programs, plans, and concrete goals.

Some notable works in the group of studies on local industrial development include: Vu Thanh Huong's doctoral dissertation (2010) titled "Sustainable Development of Industrial Zones in the Northern Key Economic Region", Nguyen Ngoc Dung's research (2011) on "Integrated Development of Industrial Zones in Hanoi", Nguyen Dinh Trung's doctoral dissertation (2012) on "Infrastructure Development for Industrial Clusters in Hanoi", and Nguyen Tuan Anh's (2024) research on "Cultural Industry Development Policies in Hanoi".

Although there has been considerable research on industrial development at both national and local levels, the number of studies focused on industrial development in major cities, especially Hanoi, with sustainability and cultural characteristics of the capital, remains limited. Current studies mainly focus on the development of industrial zones, as well as the history of the formation and development of Hanoi's industrial sector.

According to the perspective of the World Commission on Environment and Development (WCED) published in 1987, industrial development is not only about promoting economic growth but also about paying attention to social equity, the rational use of natural resources, and environmental protection. Based on the synthesis of existing studies and the perspective on sustainable development, this paper will propose suggestions for industrial development in Hanoi, contributing to the sustainable development of the capital.

3. Methods

Data was collected from reports by the Ministry of Planning and Investment, the Hanoi Statistics Office, and statistics on the four main industrial sectors as classified by the General Statistics Office of Vietnam: (1) Mining Industry; (2) Manufacturing and Processing Industry; (3) Production and Distribution of Electricity, Gas, Steam, and Air Conditioning; (4) Water Supply; Waste and Wastewater Management and Treatment Activities.

This study employs methods such as analysis, synthesis, descriptive statistics, and survey data comparison to analyse the development status of Hanoi's industrial sector. Based on the findings of the analysis, the research will suggest solutions for sustainable industrial development in the city of Hanoi.

4. Results

4.1. Achievements in industrial development in Hanoi

Firstly, despite fluctuations in the proportion of the industrial and construction sectors during the 2014-2023 period, the economic structure of Hanoi continues to shift toward modernization, aligning with the national industrialization and modernization strategy. In 2023, the city's Gross Regional Domestic Product (GRDP) reached 821 trillion VND, an increase of 6.27% compared to the previous year. The development of the industrial and construction sectors remains noteworthy, growing by 5.29% in 2023 and contributing 1.18 percentage points to the city's GRDP growth. The manufacturing and processing industry continues to play a crucial role, with a growth rate of 4.28%, contributing 0.55 percentage points to the overall increase (Hanoi Statistics Office, 2024). According to Son Trang (2023), during the 2011-2022 period, Hanoi's industrial and construction sectors achieved an average growth rate of 8.19% per year, higher than the national average of 6.67%. This underscores the significant role of the industrial and construction sectors in maintaining the city's economic growth, while also reflecting the effectiveness of the city's support and development policies, even in the face of global challenges such as the COVID-19 pandemic.

Secondly, in the structure of Hanoi's industrial sectors in recent years, the manufacturing and processing industry has accounted for a significant proportion.

According to data from the Hanoi Statistics Office, the city's Gross Regional Domestic Product (GRDP) at 2010 constant prices increased from 410.316 trillion VND in 2014 to 821.484 trillion VND in 2023. In this growth, the manufacturing and processing industry played a key role, with production value increasing from 84.781 trillion VND in 2014 to 100.897 trillion VND in 2023, accounting for approximately 12% of the city's total GRDP (at 2010 constant prices).

In 2023, the industrial and construction sector grew by 5.29%, contributing 1.18 percentage points to the city's GRDP growth. The manufacturing and processing industry continued to play an important role with a growth rate of 4.28%, contributing 0.55 percentage points to the overall increase. Although the growth rate of the manufacturing and processing industry did not reach the level of the previous year, this growth still reflects the efforts of enterprises, especially amid global market challenges and declining orders. Overall, in 2023, the added value of the industrial sector increased by 4.57% compared to the previous year, contributing 0.64 percentage points to the total added value growth of the entire city. The manufacturing and processing industry, along with other material production sectors, has driven the development of services in the capital, meeting the growing demand for goods and services from the people of the capital and neighboring provinces.

Table 1: Gross Regional Domestic Product (GRDP) of Hanoi

(at 2010 Constant Prices by Economic Sector; Unit: trillion VND)

Year	Total	Agriculture, forestry, and fishery	Mining and quarrying	Manufacturing	Electricity, gas, steam, and air conditioning supply	Water supply; sewerage, waste management and remediation activities
2014	410316	14497	427	84781	4024	2465
2015	497473	13100	440	61542	3195	2608
2016	533091	13493	305	65999	3404	2817
2017	572503	13711	232	71872	3697	2961
2018	614035	14260	203	77694	4025	3172
2019	662023	14247	143	84169	4458	3428
2020	689257	14894	150	86241	4838	3789
2021	709492	15382	146	89627	5040	4058
2022	772981	15797	144	96760	5345	4424
2023	821484	16230	141	100897	5765	4748

Sources: Hanoi Statistics Office

According to data from the Hanoi Statistics Office, from 2014 to 2023, investment capital in the city increased significantly, from 192.674 trillion VND in 2014 to 344.200 trillion VND in 2023. During this period, the manufacturing and processing industry attracted considerable investment, with capital increasing from 20.362 trillion VND in 2014 to 31.547 trillion VND in 2023. The production and distribution of electricity, gas, steam, and air conditioning sector also saw a strong rise in investment, from 20.942 trillion VND in 2014 to 39.567 trillion VND in 2023. The proportion of investment capital in these two sectors fluctuated between 20% and 25% of the total investment capital from 2014 to 2023 (Hanoi Statistics Office, 2024).

Among the sources of this investment, about 20% came from the state budget, while the remaining portion was contributed by domestic and foreign investors, helping to alleviate the pressure on the city's budget expenditures.

By the end of 2022, Hanoi had granted licenses to 654 investment projects in the manufacturing and processing industry, out of a total of 7,348 investment projects. The realized investment capital in this sector reached the highest level at 6.611 million USD, accounting for 25% of the total 26.003 million USD of investment capital. By the end of 2023, the number of investment projects in the manufacturing and processing industry had increased to 873 projects, continuing to hold the largest proportion of the total 7,360 investment projects. The realized investment capital in this sector reached 6.955 million USD, accounting for about 25% of the total 27.768 million USD of investment capital.

Table 2: Licensed Foreign Direct Investment by economic sector in Hanoi
(Total active projects up to December 31, 2023)

	Number of Licensed Projects (Projects)	Total Registered Capital (Million USD)	Realized Capital (Million USD)
Total	7360	42171	27768
Agriculture, forestry, and fishery	23	78	63
Mining and quarrying	3	29	25
Manufacturing	873	10313	6955
Electricity, gas, steam, and air conditioning supply	25	353	324
Water supply; sewerage, waste management and remediation activities	22	1670	1021

Source: Hanoi Statistics Office

Thirdly, the formation of economic zones, industrial parks, and industrial clusters in various areas across the city aims to achieve balanced and harmonious development of Hanoi's economic regions. Currently, Hanoi has 11 industrial parks covering an area of 2,461.17 hectares, which have been approved by the Prime Minister in the master plan for the development of Vietnam's industrial parks until 2025, with an orientation toward 2030 (Hanoi industrial and export processing parks management Board, 2023). These industrial parks are widely distributed across districts and counties within the city, ranging from the Hanoi Biotech High-Tech Park (Habiotech) in the northwest to the Southern Hanoi Supporting Industrial Park (Hansip) in the south. Notably, the Thang Long Industrial Park and the South Thang Long Industrial Park occupy large areas and hold strategic locations, significantly contributing to the economic development of the surrounding regions.

Fourthly, the city's leadership has actively promoted administrative reforms, created a favorable business environment, supported industrial development, and simultaneously addressed employment and increased income for workers. In 2023, the industrial and construction sectors attracted 1.318 million workers, accounting for 32.7% of the total workforce in Hanoi. The average income of workers in the industrial sector in Hanoi is relatively high compared to other localities across the country. Hanoi not only attracts a large number of workers to the industrial sector but also ensures a relatively high income level, contributing to the improvement of workers' quality of life.

Table 3: Average income of Hanoi workers by economic sector
Unit: Thousands VND

	Total	Mining and quarrying	Manufacturing	Electricity, gas, steam, and air conditioning supply	Water supply; sewerage, waste management and remediation activities
2014	6530	8513	5819	10859	7146
2015	7434	9180	6791	12160	7538
2016	7535	11996	6884	14348	7878
2017	8868	9814	8579	15829	7868
2018	6395	9451	6286	8330	6044
2019	7665	11157	7292	10969	7160

	Total	Mining and quarrying	Manufacturing	Electricity, gas, steam, and air conditioning supply	Water supply; sewerage, waste management and remediation activities
2020	7090	14919	7220	11032	6200
2021	7712	10794	7086	9628	6666
2022	8859	15577	8056	10393	8183
2023	9833	13350	9246	11484	8869

Source: Hanoi Statistics Office

According to data from the Hanoi Statistics Office, the average income of workers in the manufacturing and processing industry increased from 5,819 thousand VND in 2014 to 9,246 thousand VND in 2023. This significant increase reflects the development and improvement in working conditions in Hanoi's industrial sector. The production and distribution of electricity, gas, steam, and air conditioning also recorded an increase in income, from 10,859 thousand VND in 2014 to 11,484 thousand VND in 2023.

Fifthly, Hanoi is one of the pioneering cities in Vietnam to issue a Resolution on the development of cultural industries, aiming to leverage the advantages of the "Heritage Capital" with numerous monuments, craft villages, and unique festivals. This has significantly contributed to the strong recovery of tourism in the capital and the annual increase in revenue from tourists.

Moreover, Hanoi is also leading in the establishment of a sustainable production and consumption network in the electronics and household goods sectors. This program connects production chains, boosts domestic consumption demand, supports manufacturing and business enterprises, and promotes products while encouraging sustainable and stable development.

4.2. Limitations in industrial development in Hanoi

Firstly, industry holds a relatively small share in Hanoi's economic structure, making the city not among the top localities with the highest industrial proportions in the country. In 2023, the service sector accounted for the largest share of Hanoi's GRDP at 64.06%, followed by the industrial and construction sectors at 23.65%, product taxes minus subsidies at 10.32%, and finally the agriculture, forestry, and fishery sectors at 1.97% (Hanoi Statistics Office, 2024).

Over the past ten years, the value of Hanoi's total industrial product has not seen significant changes, accounting for only about 15% of the total local product. Despite an increase in value from 107,585 billion VND to 200,828 billion VND during this period, the proportion of industry in the total GRDP remains low, insufficient to become the main driving force for the city's economic growth.

The economic restructuring within the industrial sector has been slow compared to requirements, and the structure of the industrial sectors has not evolved appropriately. Key and spearhead industries are not yet clear, while industries causing environmental pollution but accounting for a large proportion of GRDP remain prevalent (Table 4).

Table 4: Gross Regional Domestic Product (GRDP) of Hanoi

(at Current Prices by Economic Sector)

Year	GRDP at Current Prices (Billion VND)	Industry (Billion VND)	Proportion (%)
2014	502967	107585	21.40
2015	672949	96671	14.37
2016	730935	105469	14.43
2017	806296	119183	14.78

Year	GRDP at Current Prices (Billion VND)	Industry (Billion VND)	Proportion (%)
2018	883281	133623	15.14
2019	973877	150211	15.42
2020	1017596	156360	15.36
2021	1069079	166675	15.59
2022	1194911	190540	15.94
2023	1297134	200828	15.48

Source: Hanoi Statistics Office

Secondly, in recent years, the proportion of actual investment capital in the manufacturing and processing industry relative to the total local product in Hanoi has generally been lower compared to other sectors; in 2023, it was 25.9%, significantly lower than other sectors such as mining (80.8%); water supply, waste management, and waste treatment activities (226.1%); and electricity, gas, steam, and air conditioning supply (310.0%).

Table 5: Ratio of Actual Investment Capital to Gross Regional Domestic Product (GRDP) in Hanoi by Economic Sector

Unit: %

	Total	Agriculture, forestry, and fishery	Mining and quarrying	Manufacturing	Electricity, gas, steam, and air conditioning supply	Water supply; sewerage, waste management and remediation activities
2015	37.5	15.0	1687.2	32.0	671.8	82.3
2016	38.2	30.2	357.5	39.9	671.2	77.9
2017	37.9	20.5	95.,8	33.8	771.6	68.7
2018	38.4	27.7	388.5	34.2	706.5	104.1
2019	38.9	30.4	620.4	35.7	484.3	110.1
2020	40.7	21.7	205.2	36.3	397.0	246.4
2021	38.2	23.5	126.6	25.7	333.6	227.6
2022	38.,0	23.0	79.8	24.9	315.9	194.4
2023	38.3	22.9	80.8	25.9	310.0	226.1

Sources: Hanoi Statistics Office

Thirdly, training and skill development, as well as high-quality workforce training, have not met the demands of the Fourth Industrial Revolution and industrial development. The quality and productivity of labor in Hanoi's industrial sector remain low, with a significant gap compared to other countries and some domestic provinces and cities. Although labor productivity in businesses in Hanoi is higher than the national average, it is still lower than the average for the Red River Delta region.

Data from the Ministry of Planning and Investment (2023) shows that labor productivity in Hanoi increased from 15.19 times during the 2016-2020 period to 18.22 times in 2020 and 17.22 times in 2021. However, compared to the Red River Delta region, these figures are still lower, with the region achieving 18.37 times in 2020 and 17.76 times in 2021. This indicates that Hanoi needs stronger measures to improve labor quality and productivity in its businesses.

Additionally, in the Provincial Competitiveness Index (PCI) rankings for 2023, Hanoi dropped 8 places to 28th position with a score of 67.15 points (VCCI, 2024). This is the third consecutive year that Hanoi has fallen in rank, reflecting the challenges the city faces in improving the business environment and its competitiveness.

Fourthly, industrial production is one of the main sources of environmental pollution in Hanoi. The city's expenditure on environmental protection has seen significant changes in recent years, yet it remains low compared to actual needs.

In 2018, expenditure on environmental protection as a percentage of the city's regular expenditures was 2.1%, amounting to 892 billion VND out of a total of 42,222 billion VND in regular expenditures. This ratio increased to 4% in 2019, with 1,855 billion VND out of a total of 46,181 billion VND in regular expenditures. In 2020 and 2021, this ratio remained at 4.2%, with expenditures of 1,892 billion VND and 1,972 billion VND, respectively, within the total regular expenditures.

By 2022, the ratio slightly decreased to 4.1%, corresponding to 2,003 billion VND out of a total of 48,600 billion VND in regular expenditures. In 2023, the ratio increased slightly to 4.2%, with 2,237 billion VND out of a total of 53,737 billion VND in regular expenditures.

However, when comparing expenditure on environmental protection to total local government spending, this ratio is significantly lower. In 2018, expenditure on environmental protection accounted for only 0.7% of total local budget expenditure (152,906 billion VND). By 2023, this ratio had only increased to approximately 1.4% (2,237 billion VND out of a total of 165,566 billion VND in local budget expenditure) (Hanoi Statistics Office, 2024). This indicates that despite an increase in environmental protection spending, the ratio still does not adequately meet the needs given the scale of industrial development and the environmental pressures the city faces.

4.3. Causes of limitations

The implementation of the "brown to green" industrial development strategy cannot be achieved in a short period; it is a process involving planning, strategy development, implementation, and adjustments. Particularly, industries that contribute significantly but causing pollution require substantial time and financial resources for long-term changes.

The integration between economic and social development and environmental protection is not yet strong. Sometimes, development projects for industrial zones and clusters do not fully account for their negative impacts on residents' lives and environmental preservation.

The responsibility for managing sources of air pollution in major urban areas and densely populated regions is not clearly defined. Transportation activities, industrial emissions, and infrastructure development are major sources of air pollution in cities. Consequently, sectors such as natural resources and environment, industry and trade, transportation, construction, and local government offices should all be responsible for management and control. However, coordination among different levels and sectors in implementing solutions to address air pollution sources has not been effective.

Industrial zones have not been developed in depth, with a focus on high value-added sectors, modern technology, and environmental friendliness.

The economic recovery after the COVID-19 pandemic has been slow, and the disruption of supply chains due to the pandemic has impacted investment, production, and business plans.

5. Recommendations for sustainable industrial development in Hanoi

To promote economic growth, develop the industrial sector sustainably, protect the environment, and improve the quality of life for residents, Hanoi should implement the following measures:

First, develop key industrial sectors

The Hanoi city government should further improve the investment and business environment; refine mechanisms and policies to support enterprises in developing key industrial products, advancing technology, and enhancing human resources. Enhance trade and investment promotion activities and support enterprises producing key industrial products in the city. The Hanoi Department of Industry and Trade should lead and coordinate with other departments annually to select and honor key industrial products from local manufacturers.

Industrial enterprises need to proactively apply technology in production, improve product quality to international standards, and increase competitiveness to participate more deeply in the global production and supply chain. Aim to elevate the proportion of industrial enterprises in Hanoi to be among the top 500 enterprises in Vietnam and top globally recognized brands.

Second, develop green industries

Priority industries in Hanoi should be those that conserve energy, use fewer natural resources, reduce pollution, and have high recycling potential, such as high-tech industries, electronics, and environmentally friendly food processing industries. Additionally, Hanoi should promote the development of renewable energy sources such as solar, wind, and biomass energy, along with the recycling and resource recovery industries.

Support businesses in the city in transitioning to green, environmentally friendly production models, which will not only reduce negative environmental impacts but also enhance economic efficiency. Apply modern technologies such as automation, robotics, the Internet of Things (IoT), and artificial intelligence to monitor and manage production, optimize processes, and save energy.

Moreover, Hanoi should focus on developing industries that use advanced technology, are environmentally friendly, and have high value-added, such as software production, digital products, information security, mechatronics, biotechnology, biomedical electronics, and the pharmaceutical industry. This approach will prioritize industries with low carbon emissions and resource-efficient practices, contributing to environmental protection and sustainable development in Hanoi.

Third, develop ecological industrial zones

The planning and development of ecological industrial zones in Hanoi should be carried out with modern wastewater and waste treatment systems to meet environmental standards. Increase green spaces within industrial zones to improve air quality. Implement energy-saving solutions and use renewable energy in business operations.

Additionally, ecological industrial zones in Hanoi should be equipped with smart monitoring and management technologies to track environmental quality, optimize resource use, and ensure operational efficiency. Promote cooperation among businesses within the industrial zones to share resources and experiences in environmental protection. Specifically, facilitate the attraction of businesses investing in research and development of green technologies.

Fourth, raise community awareness and responsibility

Enhance public awareness about the importance of sustainable industrial development through increased education and advocacy. Encourage residents to use eco-friendly products and practice energy conservation. Actively participate in the “City Commitment” project to improve air quality and reduce greenhouse gas emissions in Hanoi.

Support businesses in fulfilling their social responsibilities, using natural resources efficiently, minimizing environmental pollution, and protecting water resources and biodiversity.

Fifth, strengthen international cooperation

Participate in international forums on sustainable development to share experiences and learn from other countries. Collaborate with advanced nations in the field of sustainable industrial development, learn from their experiences, and exchange solutions. Attract foreign investment into green, environmentally friendly industrial projects.

Develop and enhance the industrial infrastructure to attract investment in industrial zones and high-tech parks in the city. Invest in infrastructure for sustainable industrial development, including renewable energy systems, wastewater treatment facilities, and green transportation systems.

Recommendations for relevant authorities

The government and ministries need to establish a mechanism for closely integrating economic and social development with environmental protection at the local level. Implement appropriate policies to encourage production and business facilities to comply with environmental regulations and adopt clean technologies.

Strengthen the capacity of environmental management agencies by focusing on the following areas: develop a streamlined, appropriate, and effective environmental management structure; enhance planning, monitoring, and review of the "Green Growth Strategy" to ensure its implementation; improve environmental impact assessment capabilities and monitoring of environmental effects to avoid unforeseen negative impacts, ensuring harmony between environmental protection and economic development; and strengthen capacity for inspection, auditing, and enforcement of environmental laws. Publicize information about environmental pollution, legal violations related to environmental protection by individuals, organizations, and businesses through mass media to create public opinion and social pressure.

The coal and electricity sectors surrounding Hanoi should proactively collaborate with local authorities to implement plans to relocate production facilities away from residential areas, address air, water, and soil pollution issues, and ensure a healthy environmental quality of life.

Enhance education and dissemination of environmental protection and biodiversity laws, combined with communication efforts to raise awareness and responsibility among citizens, organizations, and businesses. Promote community monitoring roles and strongly condemn legal violations related to environmental protection.

Continue to improve the legal framework for investment in industrial and economic zones. Develop outstanding policies on infrastructure, land access, administrative procedures related to investment, business, construction, and dispute resolution, as well as enforcement mechanisms.

6. Conclusion

The study analyzed the industrial development situation in Hanoi during the period from 2014 to 2023, evaluating both the achievements and limitations of the capital's industrial sectors. The results show that while Hanoi has made certain progress, the city still faces numerous challenges, particularly in social and environmental aspects. Industrial development remains unsustainable, with severe air pollution and inefficient resource use.

Based on the research findings, several solutions and recommendations are proposed to achieve sustainable industrial development in Hanoi by 2025, with a vision towards 2030. Policies supporting sustainable industrial development in Hanoi need to be comprehensive, feasible, and focused on addressing environmental, economic, and social issues in an integrated manner. The results and recommendations from this study are not only relevant to Hanoi but can also be applied to other cities facing similar challenges in their industrial development processes.

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The Role of the Organic Ragworm-Rice Production Model in Achieving Sustainable Development Goals

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Abstract

The research conducted a field survey of the production model, interviewed farming households, collected data and compared the model of ragworm-rice production with the model of intensive rice production to evaluate the role of the organic ragworm-rice production model with the goal of sustainable development. The research results show that the organic ragworm-rice production model plays an important role in the goal of sustainable development. Economically, the model provides high economic efficiency, diversifies products, increases market access, and has a spillover effect on other sectors and the overall economic structure. Socially, the model creates many jobs for farmers, contributes to food security, community health, and safety, and enhances the role and status of women. Environmentally, the model contributes to the efficient use of natural resources and environmental protection, increases carbon absorption, reduces greenhouse gas emissions, and preserves biodiversity. The research proposes three solutions for developing the organic ragworm-rice model: applying organic standards and managing traceability to achieve organic certification; promoting trade promotion, linking agricultural product consumption and planning production areas.

Keywords: *Organic agricultural production model, organic ragworm-rice production model, sustainable development*

1. Introduction

In the current context, sustainable development is not just an option but a necessity to protect the planet and ensure a sustainable future for all. The Party and State of Vietnam have recognized the importance of sustainable development early on, incorporating sustainable development perspectives into resolutions, strategies, and socio-economic development plans.

Vietnamese agriculture has achieved many accomplishments; however, the quality and sustainability of agricultural growth and development methods still have significant limitations. The sector has relied on expanding cultivation areas and overusing chemical fertilizers and toxic pesticides, which negatively impact the ecological environment. Agriculture is the second-largest greenhouse gas-emitting sector after energy, making it crucial in leading Vietnam's efforts to meet international commitments on reducing greenhouse gas emissions.

The organic ragworm-rice production model is thriving in the brackish water areas of provinces like Hai Phong (over 2.000 hectares), Hai Duong (882 hectares), Quang Ninh (about 500 hectares), Ha Tinh (133 hectares), Thai Binh, Nam Dinh, Ninh Binh, and Nghe An. This model combines ragworm farming with one winter-spring rice crop, using special rice varieties popular in the market. As ragworms are highly sensitive to chemicals and only survive in clean environments, the model strictly avoids chemical fertilizers and pesticides, using only composted organic fertilizers and manual care throughout many stages.

This model won first place at the national Vietfarm - Proud of Vietnamese Agricultural Products award and has been highly regarded by international experts for its sustainable ecological farming practices and the development of local specialties (Tuan, et al., 2021).

The model is regarded as "for humanity" (not only providing economic benefits but also protecting the health of producers, consumers, the environment, and natural resources), “multi-layered” (five layers of utilization: ragworms in the soil, fiddler crabs on the field banks, rice in the fields, leafy vegetables and herbs on the field banks, and fruit trees on top), and “multi-value” (leveraging unique advantages to create added value and optimize returns per unit area of cultivation).

However, the model faces challenges such as traceability management for product standard certification, product consumption, and production area planning. Therefore, there is a need for research on this model to assess its role in sustainable development, address current difficulties, and promote the model’s positive aspects.

The objectives of the paper are to evaluate the role of the organic ragworm-rice production model in relation to the three pillars of sustainable development (economic, social, and environmental) and then propose recommendations to promote the development of the organic ragworm-rice production model toward sustainable development goals.

2. Literature review and Theoretical framework

There have been numerous studies on sustainable agricultural development conducted by organizations and individuals worldwide, including in Vietnam. The Food and Agriculture Organization of the United Nations (FAO) regularly publishes reports and guidelines on sustainable agriculture, providing theoretical frameworks and detailed analyses of the impacts of agricultural production models on sustainable development. The World Bank (WB) publishes reports on agriculture, climate change, and sustainable development that often include analyses of the economic, social, and environmental impacts of agricultural production models. The Organization for Economic Cooperation and Development (OECD) produces many reports on agricultural and environmental policies, analyzing the impacts of agricultural production models on sustainable development. Scientific journals such as *Agriculture, Ecosystems & Environment*, *Journal of Sustainable Agriculture*, and *Ecological Economics* have many studies analyzing the impacts of agricultural models.

In Vietnam, many research projects and initiatives are being implemented to build theoretical and practical foundations for sustainable agricultural development in different regions. Each locality studies and selects suitable agricultural production models, resulting in a wide variety of discussions on this topic. Some sustainable agricultural production models of interest include organic agriculture, ecological agriculture, circular agriculture, smart agriculture, and mixed agriculture.

So far, there has been no research analyzing the role of the organic ragworm-rice production model in sustainable development or providing recommendations to promote the growth of this model to contribute to sustainable agricultural development in Vietnam.

Based on the reports of FAO and WB, the theoretical framework for analyzing the role of agricultural production models in achieving sustainable development goals is shown in the following diagram.

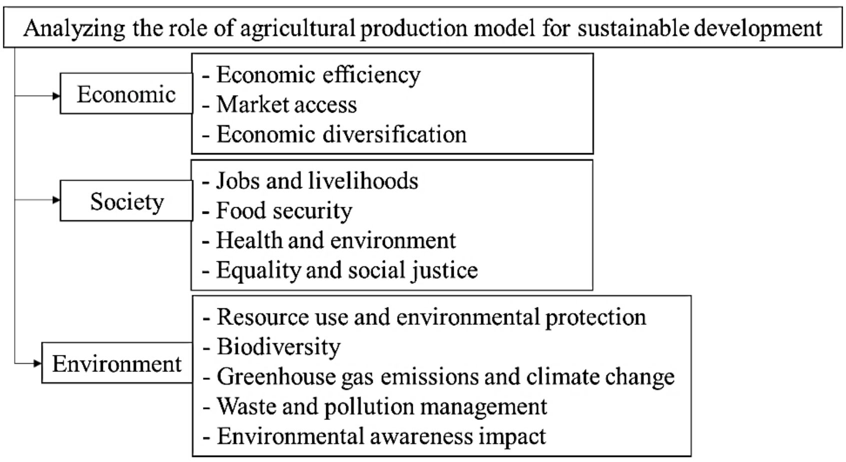

Figure 1: Theoretical framework of the research issue

Source: Author

3. Methods

- Secondary data collection method: Relevant documents include books, newspapers, journals, reports, statistical data, scientific research projects, and materials from agricultural cooperatives involved in the ragworm-rice model. The collected documents are systematized, enabling researchers to gain a comprehensive and dialectical view of the research subject.

- Comparative method: This method compares the organic ragworm-rice production model with the traditional production model and assesses the ragworm-rice model against various aspects of sustainable development to analyze its impact on sustainability.

- Interview method: (i) Qualitative Data: Collected through interviews with knowledgeable individuals (farmers, cooperative leaders, and local managers) to obtain an overview of the production model and (ii) Quantitative Data: Collected from surveys using questionnaires to reassess contextual information at the household level and measure the model's economic, social, and environmental effectiveness.

Two groups of farming households are surveyed and compared: those involved in the ragworm-rice model and those practicing double-cropping intensive rice farming. A convenient sampling method is used, with 120 survey questionnaires per model. The survey locations are An Thanh commune, Tu Ky district, Hai Duong province, and Kien Thiet commune, Tien Lang district, Hai Phong province-areas typical of organic ragworm-rice production. The questionnaire is designed in three main sections with closed questions on a 5-point Likert scale.

- Economic efficiency analysis method based on revenue and costs:

- Total Production Costs: Includes labor costs, seeds, fertilizers and chemicals, machinery, energy, and irrigation water.
- Total Revenue: The value of total production output (quantity produced multiplied by the product price) and by-products per hectare.
- Profit: The difference between total income and total costs.
- Benefit-Cost Ratio (BCR): Compares the ratio of total revenue to total costs.
- Return on Investment (ROI): Compares the profit generated from agricultural activities with the expenses incurred.
- Profit Margin: (Profit / Total Income) x 100%.

4. Results

4.1. The role of the organic ragworm-rice production model in sustainable development from an economic perspective

4.1.1. Provides high economic efficiency

The survey results from farming households are described using statistical methods, where the average value is used to characterize the model, and all values are converted per hectare.

- *Revenue:* The model's products, including ragworms, rice, and fiddler crabs, are specialties that are high in quality and safe for health, making them favored by the market and commanding high prices. The income for the intensive rice model comes from selling fresh paddy rice.

Table 1: Sources of revenue from the two production models

No.	Product	Production (tons)	Selling price (VND/kg)	Revenue (VND)
I	**Organic ragworm-rice production model**			***454.275.000***
1	Ragworm	0,97	350.000	339.500.000
2	Freshly harvested rice	4,15	10.500	43.575.000
3	Fiddler crab	0,89	80.000	71.200.000
II	**Intensive rice model (double cropping rice)**			***97.500.000***
1	Freshly harvested rice	13	7.500	97.500.000

Source: Author

- *Production costs:* Production costs include material costs and labor costs, which are converted into cash equivalents. Labor hire costs are determined based on the number of days that the household hires laborers in a production year. The labor wage ranges from 150.000 to 250.000 VND per day (at the time of the survey), averaging 200.000 VND per day.

Table 2: Average production costs of farming households

No.	Cost content	Revenue (VND)	Density (%)
1	***Organic ragworm-rice model***	***50.980.000***	***100***
-	Land preparation, embankment, plowing	4.500.000	8,8
-	Purchase rice seeds, sow seedlings	1.780.000	3,5
-	Organic fertilizers, biological products	7.500.000	14,7
-	Other supplie	5.200.000	10,2
-	Labor hire costs	32.000.000	62,8
2	***Intensive rice model (double cropping rice)***	***45.550.000***	***100***
-	Land preparation, embankment, plowing	4.500.000	9,9
-	Purchase rice seeds, sow seedlings	1.450.000	3,2
-	Fertilizers of various types	17.000.000	37,3
-	Plant protection products	9.200.000	20,2
-	Other supplie	1.400.000	3,1
-	Labor hire costs	12.000.000	26,3

Source: Author

The ragworm-rice model requires significant labor input, especially during stages such as rice transplanting, weeding and harvesting, making labor costs account for 62,8% of the total production costs.

- *Comparison of revenue, costs and profit between the two models*

Table 3: Comparison of costs, revenue and profit between the two models

No.	Criteria	Unit	Organic ragworm-rice model	Intensive rice model
1	Total revenue	VND	454.275.000	97.500.000,0
2	Total production costs	VND	50.980.000	45.550.000
-	Material cost	VND	18.980.000	33.550.000
-	Labor hire costs	VND	32.000.000	12.000.000
3	Profit	VND	403.295.000	51.950.000
4	Benefit-Cost Ratio (BCR)	Time	8,9	2,1
5	Return on investment (ROI)	%	791,1	114,1
6	Profit margin	%	88,8	53,3
7	Labor productivity	VND/ person	141.961.000	34.821.000

Source: Author

The organic ragworm-rice model yields a profit 7,8 times higher than the intensive rice model. The BCR ratio, ROI, profit margin, and labor productivity are all higher in the ragworm-rice model compared to intensive rice. Thus, the organic ragworm-rice model provides high economic efficiency, increasing income and profit for farming households.

4.1.2. Product diversification and increased market access

- Product diversification: The integrated production model incorporates multiple crops and livestock on the same land area, diversifying products and enriching the local food supply. Harvesting can occur in most months (rice is harvested in June; ragworms in May, June, and from September to December; fiddler crabs from May to October. Additionally, there are vegetables, spices, and fruit trees). This ensures steady employment and income throughout the year.

- Increased market access: Product diversification helps reduce consumption risks by enhancing access to and diversifying markets, reducing dependence on a few traditional markets. Ragworms are consumed domestically and exported to China. Ragworm field rice is consumed nationwide and exported. Fiddler crabs are consumed domestically. Fruits, vegetables, and spices are consumed locally and in nearby areas.

High-quality organic products that meet national and international standards are produced. To meet market demand and enhance competitiveness, the model strictly adheres to production processes, with products attaining quality and food safety certifications. This helps build product credibility in the market, fosters consumer trust, attracts potential customers, and expands domestic and export markets.

4.1.3. Spillover effects on other sectors and the entire economic structure, promoting comprehensive and sustainable economic development

Organic ragworm-rice production areas have great potential for developing ecological agricultural tourism due to the availability of regional traditional culinary specialties and unique organic farming methods linked to cultural traditions.

Ragworms and fiddler crabs are traditional specialties that define the local brackish river cuisine. Special organic rice is aromatic, delicious, and nutritious. These culinary specialties serve as effective marketing tools, creating distinctive highlights that attract tourists and enhance the overall tourism experience.

The organic ragworm-rice farming model attracts tourists by offering an eco-tourism experience. Tourists can participate in activities such as harvesting agricultural products, learning about organic production methods, and sustainable agriculture, creating new and unique experiences.

Hai Duong province is pioneering the development of ecotourism in the organic ragworm-rice production areas. The province has designated 750 hectares in Tu Ky district for tourism development in the rice-ragworm production areas, and is building tourism service infrastructure (transportation, telecommunications, accommodation facilities, etc.). Annually, it organizes cultural festivals associated with rice-ragworm production, such as the Organic Rice-Ragworm Festival and the Fish Catching Festival.

High-value agricultural products require processing to ensure and enhance their value. This drives the establishment and development of the agricultural processing industry in local areas.

The large-scale development of the model creates demand for transportation, storage, and distribution services. Specialty products requiring high-quality and aesthetic packaging provide opportunities for the development of the packaging industry.

4.2. The role of the organic ragworm-rice production model in sustainable development from a social perspective

4.2.1. Creating jobs and livelihoods, reducing idle time and seasonality

According to the results of questionnaire interviews in An Thanh commune and Kien Thiet commune, each farming household involved in the ragworm-rice model has 3,2 laborers per household and 90 labor days per year, which is higher than the intensive rice model (2,8 laborers per household and 60 labor days per year).

The survey results on workers' perceptions of employment opportunities from the ragworm-rice model compared to the intensive rice model also indicate differences in employment between the two models.

Table 4: Evaluation of employment effectiveness of the model

No.	Content	Evaluation results				
1	*Comparison of employment in two models*		*Organic ragworm-rice model*		*Intensive rice model*	
-	Average number of laborers per household		3,2		2,8	
-	Number of seasonal workdays		90		60	
2	*Workers' perception of the ragworm-rice model*	*Scale*	*%*	*Score*	*%*	*Score*
-	Does the model create more direct jobs?	(1) Very little	3,3	4,06	6,7	3,68
		(2) Little	6,7		9,2	
		(3) Average	17,5		25,8	
		(4) Much	25,8		26,7	

		(5) Very much	46,7		31,7	
-	Does the model contribute to indirect jobs?	(1) Very little	4,2	3,87	19,2	2,74
		(2) Little	6,7		23,3	
		(3) Average	24,2		30,8	
		(4) Much	28,3		17,5	
		(5) Very much	36,7		9,2	
-	Satisfaction level with job changes due to the model?	(1) Not satisfied at all	4,2	3,73	5,8	3,55
		(2) Not satisfied	7,5		9,2	
		(3) Average	27,5		30,8	
		(4) Quite satisfied	32,5		32,5	
		(5) Very satisfied	28,3		21,7	
2	***Comparison of employment before and after applying the ragworm-rice model***		***Before***		***After***	
-	Average working hours per day (hours)		9		6	
-	Total working days per year (days)		312		120	
-	Monthly income (VND)		9.000.000		3.000.000	

Source: Author

The ragworm-rice model creates many direct jobs by producing multiple crops on one area, increasing the workload, extending working hours, and employing manual labor in many stages.

The model also generates numerous indirect jobs, such as processing ragworm and fiddler crab products; working in collection, processing, and packaging facilities; product transportation; and tourism-related jobs.

Compared to traditional models, the ragworm-rice model reduces idle time and seasonality because it is a rotational farming model involving ragworms, rice, fiddler crabs, fruit trees, and vegetables, thus providing year-round employment. The products have staggered care and harvesting times, preventing conflicts, mutual impacts, or labor competition.

4.2.2. Contributing to food security

In the context of national food production challenges due to shrinking rice cultivation areas, the additional winter-spring rice crop in ragworm fields contributes to increasing rice output, providing safe food for consumers, and enhancing food security. In many localities, while the total rice cultivation area and output in the province have decreased, the rice area and output in ragworm fields have increased.

For example, Hai Duong province's rice output in ragworm fields was 2.200 tons in 2022 and 4.400 tons in 2023; the proportion of total winter-spring rice output increased from 0,6% to 1,25%.

The ragworm-rice production model contributes to achieving the overall goal of the agricultural sector to transform crops on low-efficiency rice land, increase farmers' incomes, and positively shift the agricultural product structure. It promotes the growth of organic, high-quality, safe, and healthy agricultural products, contributing to the creation of regional specialty products under the "One Commune, One Product (OCOP)" program. Thanks to the ragworm-rice model, the structure of rice varieties has shifted towards increasing the area of high-quality rice while reducing the area of conventional rice.

4.2.3. Health and safety for workers and consumers

Safe, nutritious, and naturally flavored organic products

Rice is a staple crop, and its production and quality significantly impact the community. Organic rice grown in ragworm fields is cultivated using completely organic methods without chemical fertilizers and pesticides, thus reducing the risk of harmful chemical residues in the rice. Analyses of organic rice from ragworm fields did not detect common pesticides, according to TCVN 11888:2017 (Vietnam national standard for white rice) (Tuan, et al., 2021).

Organic rice from ragworm fields is nutritious and delicious due to the naturally rich soil enriched with organic fertilizers. The farming process closely aligns with nature, retaining more nutrients, and the strict management of product processing preserves the quality and flavor of the rice.

Ensuring health for workers

The author conducted a survey using a questionnaire to evaluate workers' exposure to agricultural chemicals, health conditions, related illnesses, food quality, and environmental quality.

The evaluation results show that the organic production method reduces the level and frequency of workers' exposure to harmful agricultural chemicals, decreases the incidence of chronic or acute diseases related to chemical exposure, and minimizes the negative impact of chemicals on air and water quality, thus protecting the health of workers and the community.

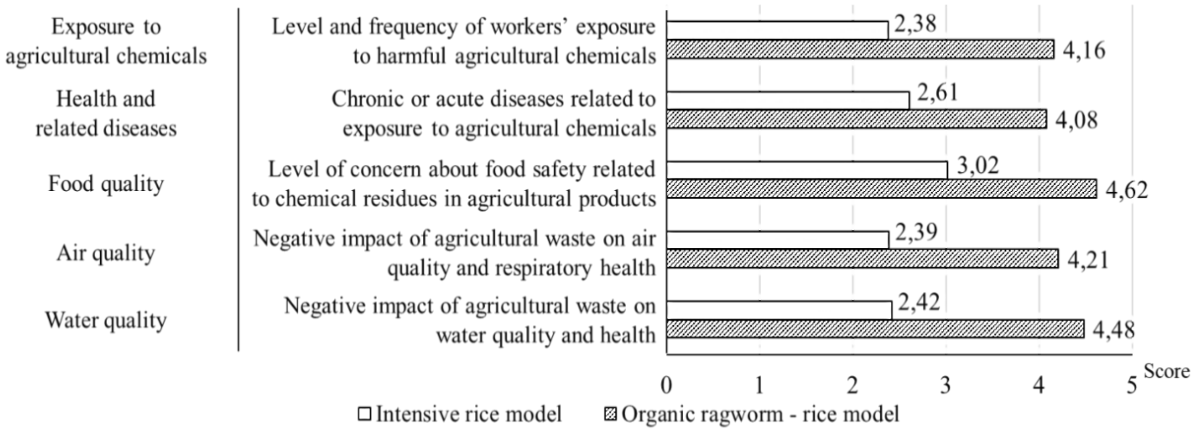

Figure 2: Impact of the ragworm-rice model on health and living environment

Source: Author

4.2.4. Enhancing the role and status of women

Creating jobs and income for women

The survey results show that the ragworm-rice model contributes to promoting women's participation in production and increasing income for female workers. The participation of female labor in production scored 3,35 points, while income for female labor scored 3,89 points.

Table 5: Impact of the model on employment and income of women

No.	Criteria	Scale	Organic ragworm-rice model		Intensive rice model	
			%	*Score*	*%*	*Score*
1	Participation of female labor	(1) Very low	5,0	3,35	7,5	3,47
		(2) Low	10,8		12,5	
		(3) Average	32,5		24,2	
		(4) High	47,5		37,5	
		(5) Very high	4,2		18,3	
2	Increased income for female labor	(1) Very low	3,3	3,89	10,0	3,35
		(2) Low	7,5		17,5	
		(3) Average	50,8		25,8	
		(4) High	19,2		20,8	
		(5) Very high	28,3		25,8	

Source: Author

Promoting gender equality

Compared to the intensive rice model, the percentage of women making decisions is higher in the ragworm-rice model (24,2% compared to 17,5%). The level of women's participation in production decision-making scored 2,8 points, showing an improvement compared to traditional farming models.

Table 6: Farmers' feedback on family decision-making

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Criteria</th><th colspan="4">Evaluation results</th></tr>
<tr><th colspan="2">Ragworm-rice model</th><th colspan="2">Intensive rice model</th></tr>
<tr><td>1</td><td colspan="2">Main decision-maker on production matters</td><td colspan="2">%</td><td colspan="2">%</td></tr>
<tr><td rowspan="5"></td><td colspan="2">Husband</td><td colspan="2">44,2</td><td colspan="2">47,5</td></tr>
<tr><td colspan="2">Wife</td><td colspan="2">24,2</td><td colspan="2">17,5</td></tr>
<tr><td colspan="2">Both husband and wife</td><td colspan="2">20,8</td><td colspan="2">26,7</td></tr>
<tr><td colspan="2">Children</td><td colspan="2">7,5</td><td colspan="2">6,7</td></tr>
<tr><td colspan="2">Others</td><td colspan="2">3,3</td><td colspan="2">1,7</td></tr>
<tr><td rowspan="6">2</td><td rowspan="6">Women's participation in decision-making</td><td>Scale</td><td>%</td><td>Score</td><td>%</td><td>Score</td></tr>
<tr><td>(1) Very low</td><td>6,7</td><td rowspan="5">2,80</td><td>11,7</td><td rowspan="5">2,53</td></tr>
<tr><td>(2) Low</td><td>10,8</td><td>20,8</td></tr>
<tr><td>(3) Average</td><td>37,5</td><td>32,5</td></tr>
<tr><td>(4) High</td><td>30,0</td><td>22,5</td></tr>
<tr><td>(5) Very high</td><td>15,0</td><td>12,5</td></tr>
</table>

Source: Author

The role of women is increased because they participate more in production stages: weeding, caring, harvesting, preliminary processing, preserving, and processing products. When participating in the model, workers are able to learn, exchange experiences, and be exposed to commodity production, thereby improving their perception of gender equality.

4.3. The role of the organic ragworm-rice production model in sustainable development from an environmental perspective

4.3.1. Efficient use of natural resources and environmental protection

a. Land use and environmental protection

The organic ragworm-rice production model positively impacts land use and environmental protection in several ways:

(i) Utilizing abandoned or low-productivity land for ragworm-rice production brings multiple benefits: It increases agricultural output, enhances economic value, creates job opportunities, and boosts income for farmers and rural communities. Abandoned land often degrades, loses fertility, and is prone to erosion. By rehabilitating, restoring, and maintaining land quality, this model helps prevent land degradation and loss. Utilizing abandoned land is part of a sustainable agricultural development strategy, ensuring that land is used efficiently and responsibly.

(ii) Crop rotation enhances land use efficiency without degrading soil quality: It contributes to improving and enhancing soil nutrients through nutrient cycling and promotes soil biodiversity. The interaction between rice plants and ragworms enables efficient nutrient cycling. Rice plants use nutrients provided by ragworms, and ragworms benefit from the clean and nutrient-rich water environment created by the rice plants. This model promotes biodiversity with the presence of various beneficial microorganisms and animals, helping maintain a balanced and sustainable ecosystem. Higher biodiversity means a healthier soil ecosystem.

(iii) Organic farming without chemical fertilizers and pesticides: The model strictly avoids using chemical fertilizers and pesticides, instead utilizing decomposed organic compost. This practice protects soil resources, improves soil quality, and prevents pollution of surface and groundwater. This is a significant advantage of the organic model compared to intensive farming methods in protecting soil resources.

b. Water use and environmental protection

The hydrological characteristics of riverbank areas involve tidal water fluctuations, and the field design includes deep trenches and fishbone ditches to channel water into the fields. The irrigation method relies on adjusting sluice gates to allow water to flow naturally, using river water and the tidal cycle to regulate water flow.

Using naturally flowing water in production plays a crucial role: it reduces dependence on artificial irrigation systems, lowers costs, and saves energy. Maintaining the natural water cycle allows water to return to groundwater or surface flow after use, helping regenerate water resources. Lower demand for groundwater or other water sources reduces environmental pressure and conserves freshwater ecosystems. River water flowing into fields carries ragworm larvae, increasing ragworm harvest yields. River water flowing in and out of the fields helps clean the fields, washing away harmful pathogens that could affect rice, thereby reducing care costs and enhancing rice productivity.

4.3.2. Carbon storage and greenhouse gas emission reduction

Methane emissions are the primary greenhouse gases emitted during rice cultivation. Methane is produced when organic matter decomposes under anaerobic conditions, which occur when rice paddies are flooded. The longer the fields are flooded, the more methane is generated.

To assess the potential for greenhouse gas reduction and carbon sequestration, we use the following calculation: rice cultivation emits methane and other gases equivalent to 8,127 tons of CO_{2eq} per hectare per season (Anh, et al., 2020). The average market price for 1 ton of CO_{2eq} is about USD 5, ranging from USD 1 to USD 30 (Kollmuss, et al., 2008).

Thus, converting from double-crop rice farming to a ragworm-rice model with one rice crop per year reduces CO_2 emissions, saving an average of USD 40,635 per hectare per year, with potential savings ranging from USD 8,127 to USD 243,810 per hectare per year.

Notably, in rice cultivation within ragworm fields, the fields are fully dried for about 8 days each month and partially dried and flooded for about 20-22 days, significantly reducing methane emissions. Rice paddies that employ an alternating wetting and drying irrigation method reduce greenhouse gas emissions by about 3,5 times compared to continuously flooded fields.

4.3.3. Preservation of biodiversity in cultivation areas

The organic ragworm-rice production model positively impacts biodiversity preservation in cultivated areas through several aspects:

(i) Organic farming protects biodiversity: The organic ragworm-rice production model, which employs entirely organic farming methods, not only preserves and maintains biodiversity but also contributes to the restoration and enhancement of species richness in agricultural environments and related ecosystems. Organic production eliminates the use of pesticides, herbicides, and chemical fertilizers, protecting species and thereby maintaining and enhancing biodiversity. Organic agriculture has minimal impact on surrounding ecosystems due to the use of natural farming methods that protect water, soil, and air quality, helping to conserve species and natural ecosystems.

(ii) “Multi-layered” model enhances biodiversity: The “multi-layered” model includes ragworms in the soil, winter-spring rice on the field surface, fiddler crabs along the field banks, food crops and spices on the embankments, and fruit trees in the top layer.

Research on biodiversity in ragworm-fiddler crab areas found a high density of various species, including 64 species of higher plants from 30 families; 58 species of phytoplankton from 35 genera, 14 families, and 9 orders across 4 algal phyla; 42 species of zooplankton from 4 groups; and 24 species of benthic fauna from 23 genera, 20 families, 12 orders, and 8 classes across 5 phyla. (Trong, 2018).

4.3.4. Enhancing community awareness of environmental protection

The widespread adoption of organic farming practices has a positive impact on raising environmental awareness among local communities. Historically, to create a suitable environment for ragworms, residents in brackish water areas have been conscious of keeping their farming areas clean and avoiding chemical pollution.

As the ragworm farming model has expanded, people's environmental awareness has improved even further. In many localities, farming households have signed commitments to jointly protect the environment in ragworm-rice cultivation areas.

Survey results show high scores in two criteria: the impact on community awareness of environmental protection (4,01 points) and the impact on compliance with environmental regulations and laws (3,95 points).

5. Conclusion

The research results show that the organic rice-ragworm production model plays an important role in sustainable development, as it impacts economic, social, and environmental aspects. Therefore, expanding this model to more localities will contribute to our country's goal of sustainable development and achieving Net Zero by 2050.

Recommendations for the development of the organic ragworm-rice model:

(i) Adopt organic standards and traceability management for organic certification

Apply organic standards: TCVN 11041-1:2017: Organic Agriculture - Part 1: General Requirements for Production, Processing, and Labeling of Organic Agricultural Products; TCVN 11041-2:2017 for Organic Crop Production; and TCVN 11041-5:2018 for Organic Rice.

Establish traceability management processes: This includes a paper-based management system with forms and data entered into software. Issue traceability codes for products and display them on packaging. Electronic traceability is an appropriate measure aligned with the growing trend in science and technology.

(ii) Promote trade and strengthen agricultural product linkages

Promote through television channels, newspapers, forums, and trade fairs, participate in the OCOP program. Linking agricultural production and product consumption through contracts plays an important role. Enterprises act as a bridge between agricultural production and the market. Encouraging businesses to invest in agriculture contributes to the development of large-scale commodity production, aligned with market forecasts.

(iii) Plan organic ragworm-rice production areas

Some requirements include conducting surveys and in-depth studies of local natural characteristics, rational distribution of production areas, clearly identifying market needs and capacities, and planning technical infrastructure in alignment with broader social development plans.

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Developing a Sustainable Seaport System Towards the Green Port Model in Hai Phong

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Abstract

The development of green ports is a significant trend in the maritime industry today. This study aims to analyse the context and potential for developing sustainable seaports based on a green port model in Hai Phong. A systematic literature review was conducted, identifying three primary environmental issues in the Hai Phong Port area, including air pollution, low seawater quality, and loss of biodiversity. Furthermore, this study examines the achievements and limitations of three critical factors influencing the green port model's development at Hai Phong Port: environmental regulations, foreign capital, and stakeholder cooperation. The findings indicate that developing a sustainable seaport system in Hai Phong necessitates improvements in environmental regulations, a stronger role for the state in maritime activities, increased economic benefits for the local community, the establishment of harmonious relationships between employers and employees, and enhanced promotion of international collaboration.

Keywords: *Green ports, Hai Phong, sustainable seaports*

1. Introduction

In recent years, the development of sustainable seaports has gained increasing attention worldwide. Although seaports play a crucial role as international trade hubs, providing essential services such as cargo handling, the operations of ports have significant environmental impacts, prompting many countries and major ports around the world to actively implement green port initiatives to minimize the negative effects of seaports on the environment. Singapore, as one of the leading maritime centers, has heavily invested in green technologies such as renewable energy, advanced wastewater treatment systems, and zero-emission transportation (MPA, 2024). Rotterdam, the largest port in Europe, has also achieved notable successes in reducing emissions, utilizing renewable energy, and developing green logistics services. In Asia, ports in China, Japan, and South Korea are also actively advancing port greening efforts to meet stringent environmental standards and promote international trade.

Therefore, guiding the development of sustainable seaports is of immense significance for Vietnam, enhancing its competitive position in the international market. Among these, Hai Phong Port is recognized as an international commercial port and a key trade hub for northern provinces, showing remarkable economic growth, particularly in the maritime sector. According to data from the Hai Phong City Statistics Bureau, in the first five months of 2024, port revenue increased by 17.08% compared to the same period in 2023. However, this growth also presents significant environmental challenges, necessitating appropriate management policies and port development strategies aimed at creating a green port model. This study “Developing a sustainable seaport system following the green port model in Hai Phong” will contribute to enhancing competitiveness, attracting investment, generating new value chains, and fostering the socio-economic development of the region.

To date, several studies have utilized green port theory to analyze the role of sustainable development in constructing port models that meet relevant criteria, ensuring a balance between economic and environmental benefits (Chengying Hua et al., 2020; Jing Su et al., 2024). Other studies have highlighted the challenges faced by port operators and the port system in Hai Phong in developing green ports (Phuong, 2018; Linh, 2022). However, there is a lack of research on applying green port models to analyze the current state of port development in the Hai Phong Port area, with a view to proposing solutions to promote green port development both now and in the future.

This study will focus on analyzing the characteristics, development status, and environmental issues present in the Hai Phong Port area. Based on the assessment of current port operations and an analysis of the opportunities and challenges related to factors influencing the development of green ports, the article proposes recommendations to address the limitations, enhance strengths, and seize opportunities for developing a sustainable port system according to the green port model in Hai Phong.

2. Methods

Port sustainability is the business strategies and activities that meet the current and future needs of ports and all stakeholders while protecting and maintaining natural resources and the welfare of humanity (Denktas-Sakar G & Karatas-Centin C, 2012). A green port is defined as a product of the long-term strategy for sustainable and climate-friendly port infrastructure development (Pavlic et al., 2014). Green ports are an excellent strategy to reduce environmental pollution and ecological harm, as well as to maintain the ports' water resources and natural environment (Anastasopoulou et al., 2011). This study is based on the following research model (Figure 1).

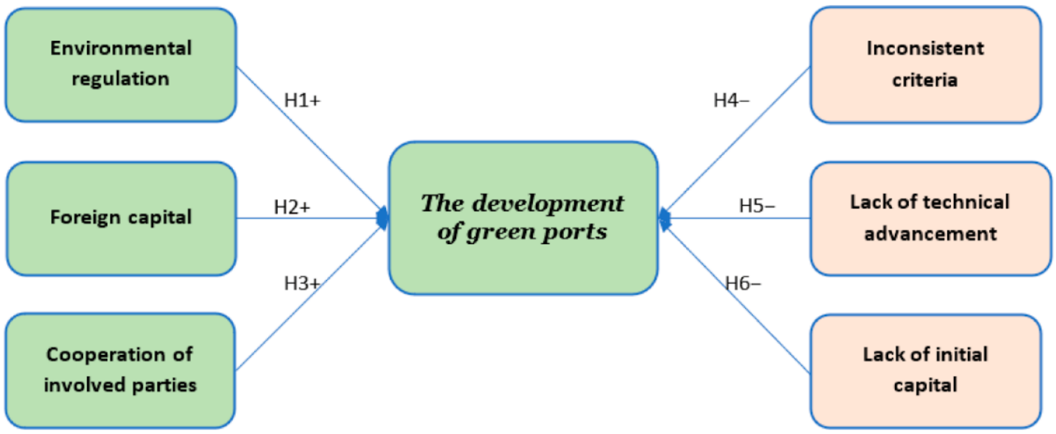

Figure 1: The research model

Source: Le & Nguyen, 2023

According to the model, there are three factors that promote the green port model: environmental regulation, foreign capital, and cooperation of involved parties. In contrast, lack of technical advancement, insufficient initial capital, and inconsistent criteria will hinder the development of green.

This study employs qualitative methods, including data collection and analysis, and comparing theories with practical observations, to assess the operational status of Hai Phong Port and related policies. This approach aims to propose solutions for developing a sustainable and effective port system.

3. Results

3.1. Current environmental state of Hai Phong's Port system

There are several issues existing in Hai Phong Ports, including air pollution, low seawater quality, and loss of biodiversity.

In Hai Phong, key industries, including shipbuilding, are energy-intensive and contribute to high levels of air pollution. Average PM10 concentrations at Hoang Dieu, Chua Ve, and Tan Vu terminals are 142 µg/m³, 136 µg/m³, and 141 µg/m³, respectively (Nguyen Thi Tuyen & Vu Thi Hue, 2021). Dust pollution is particularly severe around the Tan Vu terminal due to ongoing construction and traffic. These dust particles can impact human health, worsening respiratory conditions like asthma.

According to the Institute of Marine Environment and Resources, seawater quality has been decreasing. Port activities in Hai Phong lead to 3000 to 5000 tonnes of waste oil annually. Only 20%-30% of oil waste is collected, and the rest is discharged into the sea. Besides, considering the large number of shipyards for maintenance and new construction in Hai Phong, it's probable that the dredged sediments are significantly polluted. Hai Phong experienced record-breaking water pollution levels in 2018.

Another issue relates to the loss of biodiversity in Hai Phong Ports. Between 2015 and 2020, nearly 3 million cubic meters of material were dredged each year, with an additional 14.5 million cubic meters removed from the Lach Huyen and Ha Nam channels during 2018-2019 (Nguyen Thi Tuyen & Vu Thi Hue, 2021). This dredging has adversely impacted local ecosystems and biodiversity both in the source areas and where the sediments are deposited. Port-related waste, including oil, has further disrupted these ecosystems. Mangroves, seagrass, tidal sands, lagoons, and coral reefs have been particularly affected, leading to the decline of crucial aquatic species like shrimp and crabs. The renovation of old ports and the construction of a new deep-sea port in Lach Huyen have also harmed local biodiversity. Hai Phong's location at an estuary with valuable ecosystems, including mangrove forests, coral reefs, and aquaculture areas, makes the nearby international port's proximity to the Cat Ba biosphere reserve a potential source of further environmental degradation.

3.2. Factors that influence the development of green ports in Hai Phong

Environmental regulation

Currently, Hai Phong seaports have been implementing environmental protection measures including collection measures and solid waste management; hazardous waste management; wastewater collection, and treatment. There are a number of seaport enterprises that have applied and effectively operated the system environmental management TCVN ISO 1400: 2010/ISO 14001- 2004 for management activities of ports, particularly Chua Ve Port which belongs to the Port Joint Stock Company Hai Phong. The Hai Phong Port regulations issued by the Vietnam Maritime Administration include rules concerning maritime safety, maritime security, order, and sanitation at the ports.

Most ports in Hai Phong adhere to and strictly implement the current regulations on environmental protection. However, the quality, quantity, and effectiveness of these measures remain relatively modest and have not been fully realized. There is a notable deficiency in the deployment of effective equipment and methods for pollution prevention and treatment. Specifically, there is a lack of advanced automatic environmental monitoring systems, as well as insufficient infrastructure for waste collection and treatment, including garbage management systems. As a result, while regulatory compliance is present, the practical execution and technological support necessary for substantial environmental protection improvements are still lacking. Some ports continue to show lax adherence to environmental regulations, often evading inspections and oversight by regulatory authorities responsible for monitoring environmental pollution. The legal framework for environmental protection is still limited, with administrative penalties being too lenient to serve as an effective deterrent. Consequently, violations of environmental laws are frequent, driven by the perception that the cost of fines is less burdensome than investing in compliance with environmental regulations.

Foreign capital

Between 2010 and 2019, the implemented foreign direct investment (FDI) showed an upward trend, peaking in 2019 at 51.941 trillion VND. In 2020, FDI declined due to the COVID-19 pandemic but began to rise again in 2021 and 2022. The growth rate of implemented FDI also followed an increasing trend during the 2010-2019 period, reaching its highest rate in 2018 at 83.34%. In 2020, it decreased by 22.93%, and since 2021, the growth has slowed. In 2010 and 2011, the proportion of implemented FDI was modest, accounting for just over 10% of the total implemented investment in Hai Phong. However, starting in 2012, this proportion began to increase, reaching 20.19% in 2012 and continuing to rise steadily through 2022, with a peak of 36.02% in 2021. In 2023, Hai Phong attracted 78 new foreign direct investment (FDI) projects with a total investment capital of 1.5 billion USD. Additionally, the city approved an increase in investment capital amounting to 1.946 billion USD for 46 previously established FDI projects. This brought the total FDI capital attracted in the year to 3.446 billion USD, making Hai Phong the second highest FDI attracting locality in the country, after Ho Chi Minh City (Dong Bac & Mai Hoang, 2024).

Overall, FDI growth is a positive sign in the process of sustainable seaport development because attracting more foreign capital will promote economic productivity and infrastructure development at Hai Phong Ports. The port infrastructure and its connecting transportation systems are increasingly being upgraded with modern and integrated investments. However, the green port development process requires a high initial cost with resources needed for the training of human resources for the management and upkeep of green ports. The quality of planning for some of Hai Phong's ports is limited, characterized by small scale, numerous ports, narrow backup areas, and insufficient consideration of technical infrastructure, transport connectivity, and regional integration. This has led to an underutilization of Hai Phong's potential and advantages in port services. The processes of researching, investing in equipment, and managing operations have significant shortcomings, resulting in frequent incidents such as cable breaks, container drops, barge sinkings, crane failures, and accidents involving hazardous cargo. These issues adversely affect productivity, service quality, and operational efficiency at Hai Phong's ports. The economic and social benefits generated by Hai Phong's ports are not commensurate with the resources utilized and the potential available, particularly for bulk cargo and specialized ports. In addition, the local workforce's expertise in specialized fields, information technology, and foreign languages is inadequate. This poses significant challenges for ports and maritime enterprises in recruiting and attracting local talent, as well as in addressing local employment needs. Therefore, there will be pressure on Port authorities in Hai Phong to raise a significant initial capital source for building a green port.

Cooperation of involved parties (shipping firms, transportation companies)

The awareness of environmental protection among port enterprises in Hai Phong has progressively improved, with increasing attention paid to environmental regulations. Most shipping firms and transportation companies comply with current environmental guidelines rigorously throughout the project lifecycle, from selection and construction to operation. Some ports have actively promoted environmental awareness among employees through regular training, encouraging active participation in environmental law compliance. Furthermore, investments in advanced, modern, and eco-friendly loading, unloading, and transportation equipment have significantly contributed to the promotion of clean production, green business practices, and environmental sustainability. Notably, the Vip Greenport at the Dinh Vu Economic Zone, developed by Viconship and its partners, exemplifies leadership in advancing the green port model in Hai Phong.

However, several port enterprises have not fully embraced their social responsibilities. Issues have arisen regarding labor rights, including disputes between employers and employees, and some companies have been negligent in fulfilling their obligations such as social and health insurance contributions. Furthermore, there is a noticeable lack of proactive involvement in community and social development activities, such as supporting poverty alleviation and rural development funds. This indicates a need for enhanced commitment to corporate social responsibility within the port sector.

4. Conclusion and Recommendations

4.1. Conclusion

With the topic "Developing a sustainable seaport system following the green port model in Hai Phong", the study has fundamentally addressed the proposed requirements. First, the study clarifies the concepts of sustainable seaports, green ports, and provides a basic explanation of the green port model applied. Second, it analyses the current environmental status of Hai Phong Port, identifying existing environmental issues such as air pollution, low seawater quality, and loss of biodiversity. Third, this study assesses and evaluates the achievements and limitations of factors affecting the development of the green port model at Hai Phong Port, including three factors: environmental regulation, foreign capital, and cooperation of involved parties.

4.2. Recommendations

There is a strong encouragement for Vietnamese vessels operating domestically to fully comply with Annex VI of the MARPOL Convention on energy efficiency and the International Maritime Organization’s (IMO) greenhouse gas emissions reduction strategy starting from 2025. The strategy also promotes the adoption of electric and green energy technologies or equivalent measures for new and existing port investments. By 2050, all domestic vessels are expected to transition to using electric or green energy. In 2023, the Prime Minister of Vietnam approved the "Hai Phong City Master Plan for the Period 2021-2030, with a Vision to 2050." According to this plan, Hai Phong aims to become a major port city in the region and the world by 2050, with three key pillars of development: (1) Port and logistics services; (2) Green, smart, and modern industries, and an international coastal tourism hub; (3) Transitioning to a growth model that emphasizes green transformation across economic sectors, adopting a circular economy based on science and technology, leveraging digital technology and digital transformation, developing green and sustainable infrastructure, and promoting a green lifestyle (VnEconomy, 2024).

4.2.1. Improving environmental regulations

It is crucial to improve environmental standards for the Vietnamese port system and Hai Phong Port to prevent the use of outdated equipment that has been retired in other countries but is still imported and used in Hai Phong Port. This practice leads to environmental pollution and increases safety risks due to outdated equipment with lower safety features. In addition to the general regulations of the Environmental Protection Law and other relevant regulations, it is necessary to supplement and provide more detailed environmental regulations specifically for the Vietnamese port system in general and Hai Phong Port in particular. Moreover, Hai Phong need to collaborate with relevant ministries and agencies to continue reviewing, amending, and supplementing environmental inspection and monitoring regulations for ports. It is essential to increase the fines for environmental violations and enhance the delegation of administrative penalty authority to local environmental enforcement agencies.

4.2.2. Enhancing the role of the state in maritime activities

First, strengthen the monitoring of compliance with government regulations, legal frameworks, and international conventions related to maritime safety, foreign policy, anti-smuggling, pricing policies, and marine environmental protection. Second, improve international cooperation by supporting maritime associations and integrating Vietnam into regional industry networks. The Vietnam Maritime Administration should fully participate in international maritime conventions and leverage technological and training support to modernize Vietnam's port infrastructure. Third, guide businesses in obtaining necessary certifications, such as ISO, to enhance service quality and competitiveness. Fourth, establish information centers offering consultancy on maritime transport, export-import markets, and maritime legal issues. Fifth, ensure close collaboration between national and local maritime authorities. This includes developing cooperative regulations between the Vietnam Maritime Administration and relevant government departments and improving coordination with local governments to effectively manage maritime affairs. Additionally, strengthen inspection and oversight by port authorities and maritime safety inspectors to improve the quality of operations at Hai Phong Port.

4.2.3. Increasing economic benefits for the local community and building harmonious relationships between employers and employees

It is necessary to attract local labor, provide basic skills training, and simultaneously implement land clearance and land acquisition for port development projects. Short-term training courses should be organized for local temporary workers. Attention should be paid to providing knowledge about environmental protection, including natural landscapes, ecological values, and environmental hazards associated with economic and social development. Additionally, knowledge about communication habits, environmental hygiene skills, and practices should be provided. Furthermore, there is a need to establish harmonious and stable relationships between employers and employees, with a focus on working together towards the economic and social development goals of the city and the sustainable development objectives of the Hai Phong port.

4.2.4. Strengthening promotion and international collaboration

It is crucial to enhance scientific and technological cooperation and share information on sustainable development. This includes creating products and services designed to prevent environmental pollution or to minimize the use of materials and fuel, as well as developing solutions for environmental monitoring and management. Actively collaborate with the global community to tackle shared environmental challenges, participate in emission reduction initiatives, and adhere to agreements and commitments aimed at improving living standards and ecological conditions. Revamp promotional and public relations strategies to be more innovative and professional. Boost marketing and trade promotion efforts in line with market development strategies. Advance the use of information technology in international trade promotion and broaden both bilateral and multilateral engagements.

4.3. Future Research Directions

Regarding future research directions, a broader systematic review of literature could be considered that includes academic literature on sustainable seaport development, green port models, and the practical experiences of developed countries around the world. This may provide a wider range of literature to explore and understand the conceptualization and practice of green port development in Hai Phong, aiming to assess the relevance and applicability of the factors categorized in the green port development model used in this study. A qualitative meta-analysis could also be an important step to expand the analysis and develop new green port models. Above all, what this study has confirmed is that evaluating the operational status of seaports plays a crucial role in proposing solutions for sustainable seaport development, with the goal of advancing Hai Phong Port towards becoming a green port in the future.

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Implementing the One Commune One Product (OCOP) Program of Provincial Governments: Experience of Son La province and Lessons for Localities

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Abstract

The One Commune One Product (OCOP) Program is a national program to implement the National Target Program on New Rural Development, which has a close relationship with the industrialization and urbanization, mobilization of local resources and sustainable development. This article studies how the OCOP Program is implemented by provincial governments, analyzes the implementation of the OCOP Program by Son La provincial government using secondary data on OCOP Program in the period 2020- 2023, then recommends some lessons for the localities. The results show that the implementation of OCOP Program has contributed to the province's New Rural Development. However, there should be more effort and improvemennt in OCOP Program implementation such as communication and raising awareness about the OCOP program, training and coaching to improve the quality of human resources, developing and upgrading products and model of production and business, product rating, applying science and technology in production and business of OCOP products and services, trade promotion of OCOP products, and monitoring and evaluation of the OCOP program.

Keywords: *One Commune One Product, Son La province, rural development*

1. Introduction

The OCOP program originated from Japan's "One village one product" (OVOP) movement in the 1970s, which brought many benefits to the ruralcommunities. Creativity, productivity and togetherness of community member are of most important for OVOP development (Ministry of Cooperatives and SMEs Republic of Indonesia, 2014). To date, this program has been widely deployed in more than 40 countries and territories around the world, contributing significantly to the development of rural industries, the mobilization and promotion of local resources, and the increase of income for rural people. The program has been successfully implemented in many countries such as Japan, China, Kenya, Senegal, Malaysia (OVOP), Thailand (OTOP- One Tambon one product movement), the Philippines (One town, one product movement), Indonesia (Return to village movement), and Laos (One District, One Product-ODOP) (Huyen, 2023; Linh, 2021).

In Vietnam, the OCOP program has been implemented as a pilot in Hanoi since 2013, expanding to a number of localities nationwide such as Quang Ninh (2014), Hoa Binh, Thai Binh (2016). Up to now, it has been widely implemented nationwide.

The OCOP program plays an important role in rural socio-economic development, which has a close relationship with the industrialization and urbanization, local resources, domestic and international markets. The OCOP program aims to develop suitable products, exploit and use effectively local materials and labor, and promote creativity to create unique products. The Program contributes to economic development for rural areas while developing local resources and adding value, encouraging businesses, cooperatives and production households to invest in local production. Therefore, the OCOP Program has a great positive impacts to the business community, cooperatives and producers.

The overall goal of the OCOP program is to "Develop OCOP products to promote the potentials and advantages of rural areas to increase people's income; contribute to the restructuring of the agricultural sector associated with the development of handicrafts, industries, services and rural tourism; Promote sustainable development of the rural economy, based on strengthening the application of digital transformation and circular economy, preserving cultural values, managing resources, preserving biodiversity, landscape and rural environment, contributing to building new rural areas in depth, effectively and sustainably" (Decision No. 919/QD-TTg dated August 1, 2022 of the Prime Minister approving the One Commune One Product Program in period 2021- 2025).

The implementing bodies of the OCOP Program are cooperatives, cooperative groups, small and medium-sized enterprises, farms and production households registered under the law. OCOP products include goods and tourism services of local origin, characterized by cultural values and local advantages; especially regional specialty products, craft village products, and tourism services based on the strengths and advantages of natural conditions, local raw materials, knowledge and indigenous culture.

Funding sources for the OCOP Program include central State budget, local State budget, loan, capital mobilized from businesses, cooperatives and production households, integrated capital from other programs and projects, and other legally mobilized capital.

OCOP initiatives offer hope for local government level responses to effectively address such problems as changing rural-urban demographics and migration and income gap, thus alleviating poverty (Widiyanti, 2021). The key tasks of the OCOP program are to organize the production associated with the development of typical raw material areas; Standardize processes, standards and develop OCOP products along the value chain, in accordance with advantages in production conditions and market requirements; Improve capacity and operational efficiency for OCOP entities; Promote and connect supply and demand; Build and improve the OCOP product management and monitoring system; Enhance the system capacity to support Program implementation; Enhance digital transformation.

The implementation of OCOP program is the process of putting the OCOP program into practice through preparing, directing and controlling the program to achieve the set goals. Main activities are communicating and raising awareness about the OCOP program; Training and coaching to improve the quality of human resources, enhance management capacity and practical experience; Developing and upgrading products and model of production and business; Product rating; Applying science and technology in production and business of OCOP products and services; Trade promotion of OCOP products; Upgrading and integrating the OCOP product retrieval system; Monitoring and evaluating the OCOP program of the provincial government in which the Department of Agriculture and Rural Development presides and coordinates with the Department of Finance (financial control), the Department of Science and Technology (control of implementing intellectual property laws for OCOP products), district and commune authorities (control the implementation of the OCOP Program locally).

This article studies how the OCOP Program is implemented by provincial governments, analyzes the implementation of the OCOP Program by Son La provincial government using secondary data on OCOP Program in the period 2020- 2023, thereby proposes some lessons for the localities.

2. Methods

2.1. Data sources

Secondary data are collected from credible sources. Data on Vietnam's OCOP Program is collected from the officially published documents of the National Steering Committee for New Rural Development (the Agency in charge of implementation of the National OCOP Program). Data on Son La Province's OCOP Program is collected from Provincial Public Agencies such as the Department of Agriculture and Rural Development, the Co-ordination Committee for Provincial New Rural Development (the Agency in charge of implementation of Son La Province OCOP Program). The data is collected for the period from 2020 to 2024. Besides, information and data are also collected from published research papers and articles.

2.2. Data processing method

In this study, the authors use table data where secondary data is arranged and classified by time, specific sectors and OCOP locations to facilitate the use of these data in analysis.

2.3. Data analysis method

The compative analysis method is mainly used for studying the experiences of countries in the Introduction section and evaluating the current status of OCOP program implementation by Son La Provincial government in the Results section.

3. Results

Son La province has a favorable condition in geographical location, transportation and trade for the production of local specialty products. Son La province also has diverse terrain conditions, suitable climate and weather conditions, and the rich culture of the ethnic groups in the area for developing and promoting OCOP. Besides, this province receives central budget and local budgets at all levels to implement the Program.

The New Rural Coordination Office of Son La Province is an agency that assists the Steering Committee in implementing National Target Programs, managing and organizing the National Target Program on New Rural Construction of Son La province. In the period 2021-2023, the Son La Provincial government has implemented the OCOP Program that achieved remarkable results.

3.1. Capacity building for Steering Committee for program implementation

Son La Province has established a Steering Committee to implement the OCOP Program from provincial to grassroots level (for Son La Province and 12/12 districts and cities); Established of a Council and Advisory Group to assist the Council in evaluating and classifying OCOP products and promulgated regulations of the Council and the Advisory Group. The system of Steering Committees at all levels is regularly and promptly consolidated to ensure it meets the requirements for directing and organizing the implementation of the Program.

- Provincial level: The Provincial People's Committee assigns the Department of Agriculture and Rural Development (Provincial New Rural Coordination Office) to be the standing agency, advising on the implementation of the Program.

- District level: The standing agency is the District Department of Agriculture and Rural Development (or the Economic Department of Son La city and the Agricultural Technical Center of Moc Chau district).

- Commune level: District-level agencies have directed 100% of communes, wards and towns to assign part-time officers as focal points in implementing the OCOP Program.

3.2. Make plans and guidelines for the implementation of the Program

Son La province issued Decision No. 1593/QD-UBND dated August 24, 2023 on approving the Project "Development of OCOP products in Son La province for the period 2022-2025, orientation to 2030"; Decision of the OCOP Council of Son La province on promulgating Regulations on the Operation of Evaluation Council, Evaluation Council Advisory Group and adjusting the tasks of the OCOP Products Evaluation and Classification Council under the Son La Province OCOP Program for period 2021-2025; Report on the results of the Program in 2021-2025; Documents on the implementation of the OCOP program in Son La province according to the set of criteria and process for evaluating and classifying OCOP products.

The Department of Agriculture and Rural Development also advises and issues documents annually to implement the Program during the year such as the Plan of the People's Committee of Son La province on the implementation of the OCOP Program; Plan of Son La Provincial OCOP Council on Organizing the evaluation, grading and recognition of OCOP products; Decision on strengthening the Evaluation Council and Evaluation Council Advisory Group under the OCOP Program; Decision of the People's Committee of Son La province on approving the results of evaluation, classification and reclassification of OCOP products.

3.3. Communication and awareness raising

Communication plays an important role in raising awareness of officials and people, and mobilizing the participation of the entire political system. Son La Provincial People's Committee regularly pushes the propaganda activities in order for all levels, sectors and people to understand the purpose and meaning of the program in many channels:

- Conference on the communication and implementation of OCOP program, integrated into the National Target Program on New Rural Construction.

- Answer interviews about the OCOP Program on Son La province website, newspapers and televisions to convey the content of OCOP program to all classes of people.

- Coordinate with the Department of Information and Communications to maintain the website of the National Target Program on New Rural Construction in Son La province.

- Coordinate with news agencies inside and outside the province to report and publish articles on the results of the movement, good examples, people and practices. In 2023, Son La Newspaper published more than 50 news, articles, and photos. The provincial radio and television station broadcasted 49 short reports and 03 long reports, together with 01 article on Business and Integration Magazine, 01 article on the Voice of Vietnam, 01 article on the World and Vietnam Newspaper.

3.4. Training and coaching

In 2023, the New Rural Coordination Office organized a training course on the OCOP Program with a total of 81 participants who were leaders and officials directly assigned to implement the OCOP program at district, quarter and and commune levels, as well as enterprises, cooperatives and households producing and doing business for OCOP products according to Decision No. 919/QD-TTg dated August 1, 2022 of the Prime Minister on approving the "One Commune One Product Program (OCOP) in period 2021-2025"; Plan No. 77/KH-UBND dated March 21, 2023 of the Son La province People's Committee on implementing the OCOP program in Son La province.

3.5. New development and re-evaluation of OCOP products

By end 2023, the number of OCOP products evaluated and graded 3 stars or higher is 154, of which 01 products is rated 5-stars, 56 products are rated 4-stars, and 97 products are rated 3-stars. By sectors, there are 92 food products, 7 beverage products, 6 handicraft products, 5 medicine products and 3 eco-tourism products. Most of the province's OCOP products are 3-star certified, whereas only 1 product achieves 5-star certification (Table 1). Food and beverages are still the main field of OCOP products thanks to the province’s terrain and climate advantages.

Table 1: OCOP products in Son La province

No	City/District	5 stars	4 stars	3 stars	Food	Beverage	Handicraft	Medicine	Eco-tourism
1	Son La	1	8	4	6	0	3	0	0
2	Mai Son	0	10	10	8	2	2	0	0
3	Yen Chau	0	2	9	6	1	0	0	0
4	Moc Chau	0	13	22	26	3	0	0	1
5	Van ho	0	4	6	6	0	0	0	0
6	Bac Yen	0	5	7	6	1	0	1	0
7	Phu Yen	0	3	12	7	0	1	3	0
8	Song Ma	0	1	7	4	0	0	0	0
9	Sop Cop	0	1	3	3	0	0	0	0
10	Thuan Chau	0	5	3	7	0	0	0	1
11	Quynh Nhai	0	1	6	4	0	0	0	0
12	Muong La	0	3	8	9	0	0	1	1
	Total	1	56	97	92	7	6	5	3

Source: New Rural Coordination Office of Son La province

In 2023, a total of 27 expired OCOP certification products were re-evaluated, in which 12 products got 4-star rating and 15 products got 3-star rating.

3.6. Trade promotion of OCOP products

In Son La province, there are currently 12 OCOP product introduction and sales points supported and funded by the Department of Agriculture and Rural Development to implement and meet the criteria prescribed by the Ministry of Industry and Trade.

In 2023, the Department of Agriculture and Rural Development has supported and organized booths for OCOP participation at domestic trade fairs such as Vietnam Goods Fair 2023- Honoring OCOP products in Da Nang, the 23rd International Agricultural Exhibition- AGROVIET 2023 in Hanoi, the Red River Delta Agricultural Fair and the OCOP product Exhibition 2023, the 19th Vietnam Craft Village Fair in Hanoi. Son La Department of Agriculture and Rural Development also coordinated with agencies in the province to organize "The first Son La Coffee Festival in 2023".

Through communication and promotion campaign, local people and tourists are provided with information and put priority to choosing Son La's OCOP products. Preliminary assessment of the New Rural Coordination Office for enterprises, co-operatives and households with OCOP products shows that their sales after OCOP certification increase by more than 15%, some of them even double sales such as Cooperative 19/ 5 in Moc Chau district, Quyet Thanh Cooperative in Moc Chau district, Phong Lai Tea Cooperative in Thuan Chau District, Hoa Xuan Buffalo Meat Producer, Black Garlic Cooperative in Phu Yen District... Up to now many product brands has created reputation among domestic and foreign consumers such as Bich Thao Coffee Cooperative, Ho Sam Honey and Ta Xua Tea, Trong Nguyen Tea...

Apart from the above achievements and strenghts, the implementation of OCOP program in Son La province still has some limitations since it relates to many fields, focusing on improving existing products rather than developing new products linked to raw material areas and traditional craft villages; The set of criteria for evaluating and classifying OCOP products is not fully consistent and does not cover all products; Resources for the Program are still limited, depending on the central budget while some support mechanisms have not been specified and not focusing on the development of value chains, raw material areas and processing processes; Some enterprises, co-operatives and households do not actively improve quality of OCOP products; Trade promotion activities have not created outstanding and unique highlights to change consumer awareness of OCOP products and the OCOP Vietnam brand; Intellectual property has not been given due attention by OCOP entities, many of them do not clearly understand and have not actively registered for protection of trademarks; The application of science and technology is limited because OCOP products are mainly pre-processed or simply processed with low added value. Processing technology are simple, even outdated, and do not fully meet regulations and requirements on food safety, hygiene, and environmental protection; The role of commune and ward levels in the Program has not been clearly recognized and implemented.

4. Conclusion and Recommendations

Many countries in the world that have an OCOP Program are currently paying much attention to develop OCOP products sustainably and develop the value chain to strongly participate in the circular economy, and apply clean product technology. Based on the current status of implementing the OCOP Program in Son La province, both achievements and limitations, the authors suggest some experiences for provincial governments as follows:

- The OCOP program continues to be identified as a key program for rural economic development by promoting internal resources and increasing value. Therefore, it is necessary to draw attention of local leaders and the participation of the entire political system, especially in planning and allocating resources to implement the Program.

- Regularly and continuously communicate and raise awareness from the province to district, quarter and commune levels through mass media that links and integrates with propaganda activities in building new rural areas. The communication must help the community properly perceive the OCOP program and understand that the OCOP program is a community-based economic program.

- Build a specialized structure and a team of experts that have professional expertise. The specialized agency must be empowered and play a key role in providing executive advice on the program and funding sources of the OCOP program. Incorporate the OCOP Program into resolutions and action programs of the local governments. Enhance the role of the commune level in developing local OCOP plans and supporting enterprises, co-operatives and households to participate in the Program and develop OCOP products.

- Develop OCOP products in the value chain based on the strengths and advantages of local materials, culture and indigenous knowledge towards a circular economy, ensuring a sustainable ecosystem, applying science and technology and advanced production processes to improve product quality.

- Enhance the role of enterprises, co-operatives and households in initiating and promoting OCOP products that meet market requirements to create jobs and increase people's income, especially in mountainous and disadvantaged areas.

- Strengthen trade promotion as the foundation, digital transformation as the driving force to effectively and sustainably develop OCOP products.

- Develop and issue policies promptly to support the program. The support policy should focus on activities that OCOP product owners cannot do effectively such as: Market information for OCOP products; Branding; Certification of product conformity; Intellectual property right protection and community brands for OCOP products, especially 4-star and 5-star OCOP products.

- Support OCOP producers to participate in e-commerce platforms such as Lazada.vn, Shopee.vn, Sendo.vn, tiki.vn; Voso.vn, Posmart...

- Establish an effective network between businesses, scientists and farmers to take full advantage of local resources; Provide capacity building training for farmers to have qualifications and financial capacity to access and develop sustainably OCOP products.

- Set up an information system to get feedback from districts, communes and OCOP owners and make independent assessment of the OCOP program impact for continuous improvement.

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Factors Affecting the Knowledge-Sharing Activities of University Students in Can Tho City

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Abstract

The study has identified factors affecting the knowledge-sharing activities of university students in Can Tho City using survey techniques of 455 students studying at the University. Cronbach's alpha coefficient is used to eliminate variables with low reliability, combine with exploratory factor analysis (EFA) to redefine groups of variables in the research model, and finally do a regression analysis to identify factors that affect students' knowledge-sharing activities. Research results show that factors such as Sociability, Trust, Information Technology, Instructor Support and Teamwork have an impact on the knowledge-sharing activities of university students in Can Tho City. Based on the survey results, the study proposes some solutions to promote knowledge-sharing among university students. Firstly, schools should regularly open short-term courses in the curriculum to educate and train students in listening, respect, positive living, harmony, tolerance, generosity, continuous learning and sharing knowledge. Second, it is necessary to standardize knowledge and teaching methods to help students have strong confidence in learning. Third, schools should invest in modern technological equipment so that students can quickly grasp new information and trends. Fourth, the support of lecturers during the teaching process should be increased. Fifth, enhancing teamwork skills needs attention.

Keyword: *Knowledge sharing, knowledge-sharing activities, university students, Can Tho*

1. Introduction

Knowledge not only plays an important role in organizations but is also one of the main resources that create an organization's competitive advantage. When a person leaves the organization with their experiences and knowledge without sharing these experiences and knowledge with other members of the organization, this will cause a great loss to that organization. Therefore, knowledge-sharing plays an important role in the sustainable development of individuals, organizations and society. In the university environment, knowledge-sharing needs to be emphasized even more because this is where knowledge is created, acquired and distributed. Knowledge-sharing plays an important role in student development to ensure that learning is effective and meaningful. Active and voluntary knowledge-sharing not only helps students gain more knowledge but also makes it easier for them to apply learned knowledge and practical work later, especially in a new world requiring more and more in-depth knowledge today. Along with the trend of globalization, the distance in time and space is gradually narrowing, the speed of information transmission is increasing, and the role of knowledge-sharing is becoming increasingly important.

Realizing the importance of knowledge-sharing activities in organizations in general and in universities in particular is a matter of concern. Moreover, the author has not found any previous research on determining factors affecting the knowledge-sharing activities of students in Can Tho City. Therefore, the author decided to conduct research to examine the impact of these factors on the knowledge-sharing activities of students in Can Tho City.

2. Theoretical framework

According to K. Wiig (1994), knowledge includes truths and beliefs, opinions and concepts, assessments and expectations, methods and know-how. T. Beckman (1999) believes that knowledge is drawn from information and data to actively support improving work performance, problem-solving, decision-making, learning and teaching. Davenport & Prusak (1998) define knowledge as a set of experiences, values, information and wisdom that can help evaluate and acquire new experiences and information. Nonaka & Takeuchi (1995) conceptualize knowledge as the dynamic process of humans justifying personal beliefs with "truths".

Knowledge-sharing is defined as sharing with others knowledge and ideas related to the task being performed (Gupta, 2008), or the exchange of experiences, thoughts, and understanding about any issue that to others (Kim & King, 2004). Knowledge-sharing includes the exchange of explicit and tacit knowledge at individual, group and organizational levels (Small & Sage, 2005). This requires cooperation and voluntary knowledge-sharing between individuals and groups within the organization for a common benefit (Al-Alawi et al., 2007). Effective knowledge-sharing activities will reuse individual knowledge and enhance knowledge to a new level.

According to Bradberry (2007), personality is the psychological difference between individuals, making that individual a unique individual with unique psychological characteristics. Personality includes an individual's range of emotions, thoughts, and behaviours (Carpenter et al., 2009). Since the early 1990s, numerous personality studies have demonstrated that five personality traits are sufficient to describe an individual's entire personality. Among them, the Big Five model has emerged and been expanded to describe prominent aspects of individual personality (Digman, 1990; Goldberg, 1993).

Table 1: Studies on individual personality

Author	Personal personality factors
Norman's (1963)	Extroversion, Sociability, Dedication, Emotional stability, Culture
Botwin & Buss (1989)	Extroversion, Sociability, Dedication, Emotional stability, Culture
Goldberg (1992)	Extroversion, Sociability, Dedication, Emotional stability, Understanding
Costa & McRae (1992)	Extrovert, Sociable, Conscientious, Emotionally stable, Open to experience
Paunonen et al (1996)	Extrovert, Sociable, Conscientious, Spiritual, Open to experience
Gupta (2008)	Extroversion, Sociability, Dedication, Emotional stability, Openness

Source: Compiled by the author

According to the Big Five personality traits or Big Five-factor model of Gupta (2008), the 5 factors include emotional stability, extroversion, dedication, sociability, and openness.

3. Methodology

3.1. Research method

The topic is carried out using qualitative research methods and quantitative research methods.

Qualitative research: based on the research objectives, the research topic builds a theoretical framework for knowledge-sharing activities. And on that basis, identify factors that can impact students' knowledge-sharing activities, and design and build a preliminary interview questionnaire. The next step is to directly interview students studying at universities in Can Tho City, ask for expert opinions on the appropriateness of the factors in the model, and eliminate unnecessary factors, or add elements that have not been included in the research model. From there, an official questionnaire was formed to conduct a student survey.

Quantitative research: this study tested the reliability of the scale through Cronbach's alpha reliability coefficient to check the rigour and correlation between the observed variables, combined with exploratory factor analysis (EFA), and finally, linear regression analysis was applied to test the impact between the independent variable and the dependent variable in the model.

3.2. Data collection

This study used the convenient sampling survey method, questionnaires were sent directly to students studying at universities in Can Tho city. According to J.F. Hair (2009), for factor analysis (EFA), the minimum sample size must be no less than 50 samples, preferably 100 samples, and the observed/measured variable ratio must be 5:1; this means that 1 measured variable needs at least 5 observed variables, preferably a ratio of 10:1 or more. According to D.T. Nguyen (2012), the appropriate sample size for a multiple regression model is n >=50 + 8 x p, where n is the minimum necessary sample size and p is the number of independent variables in the model.

From the above conditions, considering the model proposes 38 observed variables, the minimum sample size used for the study is 38 x 5=190. Thus, the sample size is 455 to meet the criteria.

3.3. Research model

Based on the theoretical basis and overview of previous research works, the project builds a model of factors affecting the knowledge-sharing activities of university students in Can Tho City including Extraversion, Sociability, Dedication, Teamwork, Trust, Instructor Support, Level of Competition, Rewards and Information Technology.

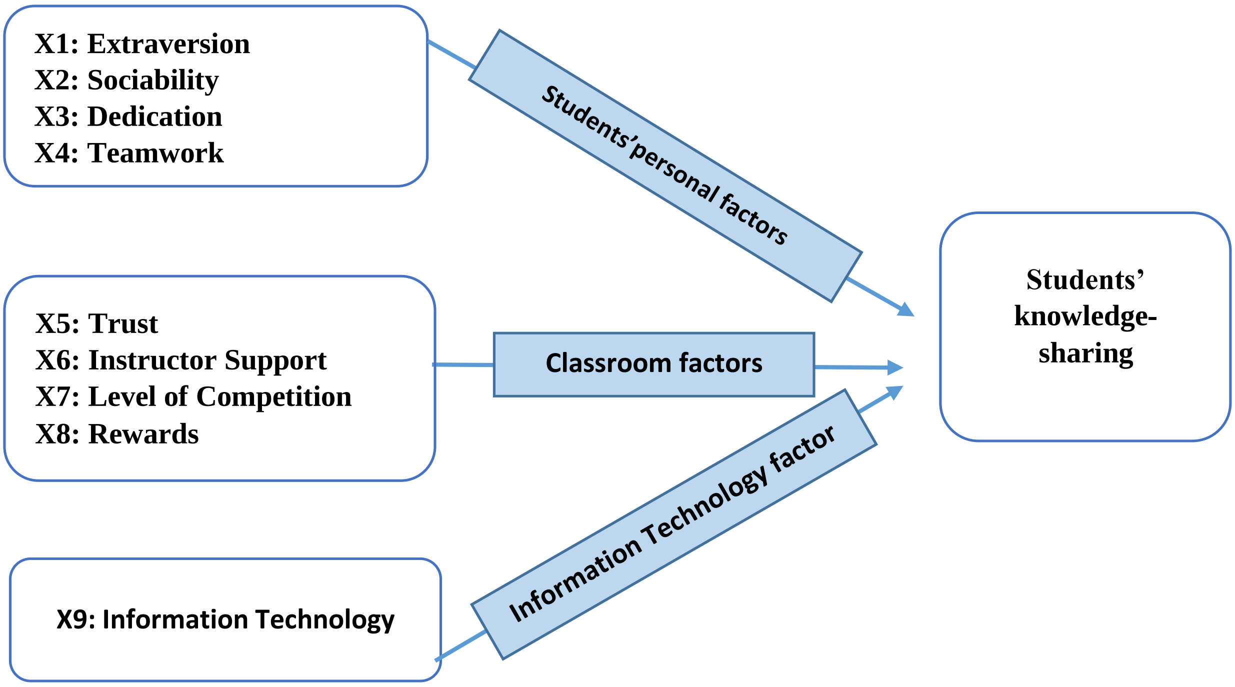

Figure 1: Research model

Source: Compiled by the author

Table 2: Scale of variables

Concept	Observation variable
Extraversion	You like to communicate with friends in class You are a person full of energy You are a passionate person You tend to like simplicity You tend to enjoy extracurricular activities
Sociability	You feel that you tend to get along with your classmates You are the one who often complains to your classmates You often help and support your friends in class You like to cooperate with your friends in class Sometimes, you are rude to your classmates
Dedication	You are a meticulous person when performing assigned tasks You are trusted by your friends when they need help You plan before performing the assigned task In the group, you are usually the one who makes plans and monitors the progress of the plan You feel that you are a highly effective task performer
Teamwork	You gain a lot of knowledge when working in groups with friends Your opinion was enthusiastically received by your friends in the group You find that teamwork effectively promotes knowledge sharing among members
Trust	You believe that your friends are capable of completing the assigned task

Concept	Observation variable
	When it comes to solving a task, friends should share knowledge with each other Your friends always try to participate in sharing knowledge with each other
Instructor Support	The lecturer encourages you to share knowledge with your classmates The lecturer encourages you to participate in discussions with your classmates The lecturer will give rewards (compliments, extra points,...) when you share knowledge with your friends in class
Level of Competition	Your academic performance depends on your friends' academic performance You feel that your friends are better able to complete the task than you are You feel like your friends are competitors
Rewards	Friends acknowledge your contribution in sharing knowledge When you share your knowledge, you will have more opportunities to demonstrate your knowledge and skills to your friends The more knowledge you share, the more your reputation grows
Information Technology	Information technology helps you share knowledge with your classmates more easily Information technology helps you find knowledge related to assigned tasks more easily Information technology makes it easy for you to contact people who can provide you with important knowledge
Knowledge-sharing	You share a lot of professional knowledge with your classmates You share many personal experiences with your classmates You share many new ideas with your classmates You share many effective methods with your friends You share many useful documents (books, ebooks, other documents,...) for studying with your classmates

Source: Results from qualitative research, 2023

4. Results and Discussion

4.1. Descriptive statistics

455 students studying at Universities in Can Tho City such as Can Tho University, Can Tho University of Engineering and Technology, Nam Can Tho University, and Tay Do University have been awarded surveys to analyze students' knowledge-sharing activities. Information is collected according to a scale of factors affecting knowledge-sharing with a total of 38 observed variables corresponding to 10 factors: extroversion factor (5 observed variables), sociability factor (5 variables), dedication factor (5 observed variables), teamwork factor (3 observed variables), trust factor (3 observed variables), instructor support (3 observed variables), competition level factor (3 observed variables), reward factor (3 observed variables), information technology factor (3 observed variables), and knowledge-sharing factor (5 observed variables).

Regarding gender, in the survey sample, 54.9% of students participating in the survey were male, and 45.1% of students participating in the survey were female. Regarding school year, 11.0% of surveyed students are first-year students, 15.4% of students are second-year students, 35.2% of students are third-year students, and 38.4% of students are fourth-year student. Regarding the school, 26.3% of surveyed students are studying at Can Tho University, 21.7% of surveyed students are studying at Can Tho University of Engineering and Technology, 24.3% of students surveyed are studying at Tay Do University, 27.7% of surveyed students are studying at Nam Can Tho University.

4.2. Factors affecting the knowledge-sharing activities of university students in Can Tho City

From the results of the first Cronbach's alpha coefficient analysis, several variables with total variable correlation coefficients less than 0.3 were eliminated: Sociability 2, Sociability 5, and Dedication 5. Second Cronbach's alpha results after eliminating variables from the first Cronbach's alpha, it shows that the second Cronbach's alpha reliability coefficient and total variable correlation coefficient both meet the requirements. All variables were accepted and used in the subsequent EFA analysis.

Table 3: Evaluate scale reliability

Numerical order	The scale	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha (Total)
1	Extroversion (E)	0.610 - 0.894	0.849 - 0.892	0.836
2	Sociability (S)	0.622 - 0.781	0.658 - 0.822	0.827
3	Dedication (D)	0.856 - 0.887	0.885 - 0.889	0.889
4	Teamwork (TW)	0.887 - 0.897	0.800 - 0.894	0.897
5	Trust (T)	0.770 - 0.898	0.855 - 0.961	0.926
6	Instructor Support (IS)	0.596 - 0.888	0.745 - 0.996	0.888
7	Level of Competition (C)	0.885 - 0.895	0.890 - 0.897	0.895
8	Rewards (R)	0.770 - 0.898	0.855 - 0.961	0.962
9	Information Technology (IT)	0.745 - 0.760	0.759 - 0.769	0.777
10	Knowledge-sharing (KS)	0.474 - 0.754	0.744 - 0.825	0.801

Source: Results of processing survey data using SPSS software

After analyzing the Cronbach's alpha reliability coefficient, 3 observed variables: Sociability 2, Sociability 5, Dedication 5 were eliminated, so the total number of remaining observed variables is 35 variables, including 30 multiplicative observed variables, independent factors and 5 observed variables, dependent factors. Perform exploratory factor analysis with The Principal Component extraction method combined with Varimax rotation for independent and dependent variables, with the following results:

Table 4: Factor analysis explores observed variables

Factor name	Observed variables	Factor						
		1	2	3	4	5	6	7
Sociability	E1	0.902						
	E2	0.907						
	E3	0.911						
	E4	0.534						
	E5	0.707						
	S1	0.730						
	S3	0.814						
	S4	0.600						
Trust	T1		0.699					
	T2		0.892					
	T3		0.880					
	R1		0.698					
	R2		0.897					
	R3		0.886					
Dedication	D1			0.957				
	D2			0.945				
	D3			0.954				
	D4			0.963				
Information Technology	IT1				0.863			
	IT2				0.880			
	IT3				0.854			
Teamwork	TW1					0.957		
	TW2					0.953		
	TW3					0.955		
Level of Competition	C1						0.970	
	C2						0.968	
	C3						0.960	
Instructor Support	IS1							0.821
	IS2							0.825
	IS3							0.583
KMO							**0.952**	
Total variance extracted							**69.267**	
Sig							**0.000**	

Source: Results of processing survey data using SPSS software

From Table 4, the factor rotation matrix shows that the factor loading coefficients of the observed variables all have values greater than 0.5. Therefore, this scale of 30 observed variables is highly reliable.

In the original research model, nine factors influence students' knowledge-sharing actions: Sociability, Extroversion, Trust, Rewards, Dedication, Teamwork, Instructor Support, Information Technology, and Competition. However, when analyzing EFA, it is grouped into seven factors. Based on the characteristics of each observed variable, the study named seven factors: Sociability, Trust, Dedication, Information Technology, Teamwork, Competition, and Instructor Support.

The results of Table 5, show that the coefficient Sig = 0.000, so the regression model is meaningful, meaning the independent variables influence the dependent variable. R^2 = 84.2% means that 84.2% of the variation in students' knowledge-sharing activities is explained by factors included in the model, leaving 15.8% of sharing activities. Students' knowledge is influenced by other factors that have not been researched. The VIF variance magnification of the variables in the model is much smaller than 10, so the variables included in the model do not have multicollinearity.

Table 5: The level of influence of factors on students' knowledge-sharing activities

*Note: *** Significance level 1%, ** Significance level 5%, * Significance level 10%*

Source: Results of processing survey data using SPSS software

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	VIF
(Constant)	0.228		2.116	0,036	
Sociability (S)	0.612	0.717	15.520	0.000***	2.139
Trust (T)	0.083	0.098	2.122	0.035**	2.145
Dedication (D)	0.029	0.330	0.937	0.350	1.226
Information Technology (IT)	0.080	0.103	2.504	0.013**	1.702
Teamwork (TW)	0.003	0.004	2.112	0.011**	1.234
Competition (C)	0.035	0.056	1.635	0.104	1.162
Instructor Support (IS)	0.058	0.077	2.739	0.084*	1.979
Number of observations (N)	455				
R^2 adjustment	0.842				
Sig	0.000				

From the results of Table 5 above, the regression equation estimates the factors affecting students' knowledge-sharing activities as follows:

KS = 0.228 + 0.612S + 0.083T + 0.080IT + 0.003TW + 0.058IS

4.3. Discussion

Based on Table 5, shows that the level of positive influence of the factors on students' knowledge-sharing activities ranked in descending order is Sociability, Trust, Information Technology, Support and Teamwork. Among these 5 factors, 1 factor (Sociability) is statistically significant at the 1% level, and 3 factors (Trust, Information Technology, Teamwork) are statistically significant at the 5% level, and 1 factor (Instructor Support) is statistically significant at the 10% level. This can be explained as follows: students who are more open and sociable easily share knowledge with other students; The more students trust each other, the more favourable conditions are created for sharing knowledge; Information technology helps students easily access new knowledge and easily exchange information with other students; The more actively students work together in groups, the easier it is to share knowledge with other students to complete assigned tasks; The more instructors encourage and facilitate information exchange, the easier it is for students to share knowledge with other students.

5. Conclusion and Recommendations

5.1. Conclusion

This research was conducted to understand and identify factors affecting the knowledge-sharing activities of university students in Can Tho City. The research model is built based on the models of authors Agyemang et al. (2016), Rahman and Hussain (2014), and Wangpipatwong (2016) with adjustments and additions to factors discovered based on data. A survey of 455 students studying at Universities in Can Tho City. The original research model was designed with 9 factors that affect students' knowledge-sharing actions: Sociability, Extroversion, Trust, Rewards, Dedication, Teamwork, Instructor Support, Technology Information, and Competition.

The study tested the reliability of the scale through Cronbach's alpha coefficient. The test results showed that 3 observed variables were eliminated: Sociability 2, Sociability 5, and Dedication 5 because the total variable correlation coefficient was less than 0.3.

Next, perform an exploratory factor analysis with the Principal Component extraction method combined with Varimax rotation, the results show that there is a grouping into 7 factors: Sociability, Trust, Dedication, Teamwork, Instructor Support, Information Technology and Competition.

The results of linear regression analysis determined that 5 factors positively impact the knowledge-sharing activities of university students in Can Tho City: Sociability ($\beta = 0.612$), Trust ($\beta = 0.083$), Teamwork ($\beta = 0.003$), Instructor Support ($\beta = 0.058$) and Information Technology ($\beta = 0.080$).

5.2. Recommendations

From the research results, the authors make several suggestions to help improve students' knowledge-sharing activities:

Firstly, improve student sociability. To improve students' sociability, it is necessary to encourage and create a learning and playing environment to help students realize the importance of sociability. Schools should regularly open short-term courses in the curriculum to educate and train students how to listen, how to respect, how to live positively, how to live tolerantly, with the spirit of generosity, and learning practice non-stop. From there, students realize the importance of the collective and sharing knowledge will also take place more smoothly.

Second, improve student confidence. To improve students' confidence, it is necessary to have support from schools and lecturers in standardizing knowledge and teaching methods to help students gain strong confidence in learning. Besides, encourage group work activities (group presentations, group exercises, group essays) as well as sharing knowledge between groups through presentation and discussion activities. In addition, the school can organize debate competitions with the motto "Speak to persuade - Speak to succeed" to create a healthy playground for students to participate. Rhetoric truly has great power and is an indispensable tool in the luggage of successful people. According to employers' assessments, the majority of Vietnamese students today are still passive and do not boldly express their ideas and opinions in front of the group. Meanwhile, training rhetoric skills for students at universities often stop at drawing experience from presentations. At the same time, there also needs to be additional reward and punishment regulations to encourage students' spirit of voluntarily sharing-knowledge, as well as create certain constraints for individual student cases.

Third, promote information technology factors. To promote information technology elements, in addition to investing in modern technological equipment for students to quickly grasp new information and trends, organizing an online library system, forums, and Virtual online communities with the participation of business/organization representatives, scientists, researchers, lecturers, etc. are equally important in motivating students to boldly share and receive knowledge.

Fourth, increase lecturers' support during the teaching process. In the classroom environment, knowledge sharing occurs when instructors encourage and motivate students to exchange and share information. Besides, the way the lecturer organizes classroom activities also affects the way students behave with knowledge sharing. Lecturers need to come up with reward policies to further promote knowledge-sharing activities through points and praise to encourage students to voluntarily share knowledge through discussions and comments. Opinion and sharing personal opinions. At the same time, setting reward and punishment regulations with students' commitment to implementation will also promote knowledge sharing and trust between students.

Fifth, enhance teamwork skills. During the teaching process, lecturers should combine teaching methods to improve students' learning efficiency. Group work should be encouraged more and more because, through this form, students will voluntarily share knowledge as well as gain knowledge easily. Forms such as group presentations, group exercises, group essays, group discussions. This is a form that brings students together. At the same time, encourage students to improve openness to create a friendly exchange atmosphere, and instruct students how to contribute opinions and how to receive contributions positively.

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International Experience in Developing Eco-Smart Communities and Suggestions for Kien Giang province

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Abstract

Developing eco-smart communities has become necessary in the present context of rapid and chaotic urbanization to endorse sustainable community development and upgrade the quality of life for local people. Kien Giang province is meeting many challenges such as climate change, urbanization, living standard disparity, migration and environmental pollution in reaching sustainable development goals. Our study provides an overview of eco-smart communities and analyzes the experiences of Kitakyushu (Japan) and Shanghai (China) in developing eco-smart communities. Based on the experiences of Kitakyushu and Shanghai, several crucial suggestions have been put forward for Kien Giang province to develop an eco-smart community in the coming time.

Keywords: *Eco-smart community, international experience, Kien Giang province*

1. Introduction

In recent years, the explosion and strong growth of the population globally have caused a lot of significant pressure on the ecological environment. According to a report by the United Nations, the global population will increase by about 25 per cent by 2050, reaching nearly 10 billion people (UN, 2022). Additionally, the rapid development of the Fourth Industrial Revolution has changed people's daily habits, environmental awareness, and access to electricity, food, health, education and so on, which led to a series of wastes that pollute the living environment. Hence, one of the most crucial questions that society needs to solve is how to make their communities more sustainable in the face of threats to ecosystems, climate change and so on. The United Nations General Assembly held the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs) to solve those changes. Goal No. 11 is related to sustainable cities and communities, which continues to be a commitment by countries worldwide, including Vietnam, at COP27.

The "smart community" development model has been researched, piloted and applied in many countries. They summarized in terms of theory, practical experience attached to the context of per locality and the goal orientations of per country. Although the development of a set of criteria and indicators to evaluate and measure the level of intelligence may be different, they aim at the common goal of building a modern, civilized community and improving the lives of people in that community in association with livelihood development and ecological environment protection.

The origin of the "eco-smart community" is to use local capital and strengths to develop socio-economic for the community. With this goal, local governments implement economic development strategies by building ecological communities. In addition, to attract tourists and promote local products, it is necessary to establish an eco-smart community in the digital age. The basic concept of "eco-smart community" is to bring together the efforts and power of people from different streams and integrate them with information technology to achieve the best benefits (Gavane, 2017).

In developed countries, the eco-smart community model is being researched and expanded. This model is a solution to help regions develop sustainably. The modernization and urbanization in Vietnam led them to migrate from one place to another in search of jobs, educational opportunities, and even higher advancement opportunities in their destinations. At the same time, creating community emotional cohesion at the destination is also considered a necessary need. Sustainable development needs to solve the problem of how people in the community generate income to maintain their lifestyle. Building an eco-smart community to fill the remaining disparities in terms of economy, education, culture, and living conditions of residents is necessary in the current context.

Kien Giang province is a coastal locality in the southwest of Vietnam with various natural resources (sea, islands, forests, wetlands) and humanistic resources (high-class resort services, festivals, traditional villages, and so on) that are favourable for economic development. However, according to a report by VCCI (2019), the Mekong Delta has 17.3 million people, with the lowest immigration rate but the highest exodus. Kien Giang ranks 7th in the region in migration rate, with about 57 migrants per 1,000 people (General Statistics Office, 2019). This region has faced the challenges of climate change (drought, floods, environmental pollution and so on). In addition, the economic structure is not solid, human resources are limited, and transport infrastructure and information technology are discrete and less attractive, forcing people to migrate to other regions. Therefore, in that context, eco-smart communities are a crucial answer to solving these problems, a mutant factor in preventing migration from Kien Giang province and the Mekong Delta. The development of eco-smart communities has taken place in many countries like China and Japan, and so on. Nevertheless, surprisingly, research on the development of eco-smart communities in Vietnam is scant. Kien Giang province is a locality in the early stages of approaching the eco-smart community model. Therefore, the article analyses countries' experiences to draw valuable lessons for eco-smart community development in Kien Giang province.

2. Literature review

Studies on the crucial of community and understanding of community have long been present in the social sciences (Amit & Rapport, 2002) but less explored in some other fields, such as rural development or the technical (information and communication technology - ICT, digital transformation or development of new digital applications and services) (Zavratnik et al., 2020).

According to Tönnies (1957), "community" is a counterweight to "society" (Gesellschaft), which is a group of people who cooperate towards common goals. In this view, a community is an entity that unites people who believe they belong to each other.

According to the U.S. Smart Cities and Communities Act, the concept of a "smart community" is defined as a community that uses innovative, advanced, and reliable information and communication technologies, energy technologies, and other related mechanisms to improve the health and quality of life of citizens; increasing the effectiveness and efficiency of operating and providing civil services; promoting economic development; create a community where people feel better about safety, security, sustainability, resilience, livability, and work.

According to Capra (2002), an ecological community is a human community in an urban or rural area, emphasizing a social environment integration that supports life with less impact on the natural environment, entailing less and more efficient energy use. Thus, an ecological community integrates various aspects such as eco-design, aquaculture, eco-construction, green production, renewable energy, and local community building. An eco-community is expected to solve many problems on earth and is an example of how to prevent and reverse environmental degradation with social, economic, ecological and spiritual measures to move the community towards sustainability in the 21st century.

According to the Global Eco-Villages Network (GEN, 2011), an eco-community is a community of people in urban or rural areas who combine a supportive social environment with a lifestyle that has a low environmental impact. The ecological community describes how people feel supported by their surroundings and are responsible for it. These communities create a deep sense of belonging as a group. They are small enough that anyone can feel safe and empowered when seen by others. People can participate in the process of making effective decisions for their own lives and society.

Thus, "eco-smart communities are communities of people in both urban and rural areas, using innovative solutions to improve their resilience, based on local strengths and opportunities. The eco-smart community relies on a community-engaged approach to develop and implement sustainable growth strategies that improve economic, social and environmental conditions by applying solutions provided by information and communication technologies."

Figure 1: Eco-smart community

Source: Compiled by authors

The theoretical framework of eco-smart communities shown in Figure 1 has been successfully applied by several developing countries such as India, Kenya, Rwanda, etc. For instance, India succeeded in developing solar and wind energy, especially in rural areas, thereby giving clean electricity to communities. At the same time, India adopted intelligent transportation solutions and digital public services. Like India, Kenya is one of the first African countries to use renewable energy, especially geothermal energy and clever water management systems. In addition, Kenya integrated intelligent technology into agriculture by providing weather data and mobile farming advice, helping people respond to climate change. Kigali (Rwanda) invested in digital infrastructure to deliver digital public services such as healthcare, transportation, and education. These countries succeeded in applying the eco-smart community model through the combination of intelligent technology and sustainable development, creating benefits for both the community and the environment.

3. Methods

Developing an eco-smart community is a complex process and goes through different stages. To carry out this study, the authors used research methods including:

- Methods of collecting information and data: We collect information and data from research papers on eco-smart communities.
- Methods of theoretical analysis and synthesis: We study different documents and theories about the eco-smart community by analyzing them in parts to gain insight. Then, we synthesize and link each dimension to create a complete and profound theoretical system of ecological intelligent community.
- Methods of analyzing and summarizing experience: We study and analyze the experiences of some Asian countries like Japan and China to draw some suggestions for eco-smart community development in Kien Giang Province, Vietnam.

In addition, to conduct practical research and apply experiences from the cities of Yokohama (Japan) and Shanghai (China) to the development of eco-smart communities in Kien Giang province, the authors developed specific steps and methods:

Step 1: Identify research aims: The study aims to understand how advanced cities such as Yokohama and Shanghai have developed eco-smart communities. Then, we apply the above experiences to solve environmental, economic, and sustainable development problems in Kien Giang province.

Step 2: Comparative analysis: In this step, the study will focus on a comparative analysis between Yokohama, Shanghai, and Kien Giang. The goal is to identify similarities and differences in geographical, economic, social, and environmental conditions between these cities through the analysis of secondary data (reports, research, and statistics from reliable sources on the cities of Yokohama and Shanghai related to the development of ecologically intelligent communities, and other data, documents on Kien Giang province, focusing on environmental issues, economic, and so on to identify the opportunities and challenges that Kien Giang is facing).

Step 3: Case study: We use a case study methodology, focusing on specific successful project analyses in Yokohama and Shanghai that can be applied in Kien Giang.

4. Results

4.1. International experience in developing eco-smart community

Many countries conducted policies for green growth and carbon emission reduction to develop eco-smart communities. Each country or city will choose different ways to achieve its goals depending on the context. This article chooses the experiences of Asian countries such as Yokohama (Japan) and Shanghai (China) in developing eco-smart communities because of the similarity in geographical conditions, circumstances and development goals of Kien Giang province.

4.1.1. Japan

Eco-smart communities are gaining attention and development in Japan as an effective solution to community problems. Japan's eco-smart communities have three outstanding characteristics including:

- Community symbiosis with the environment: In the 1970s, the oil crisis led to the pursuit of energy efficiency, which led to scrutiny of environmental concerns. This trend is evident in creating eco-communities with low carbon, recycling resources and reducing the environmental burden.
- Public transport-oriented development: Japan has focused on public transportation in the process of developing eco-smart communities. Office buildings, hotels and other commercial complexes are planned to be within walking distance of electric trains and bus stops. At the same time, residential areas are located near train stations in suburban areas.
- Resilient community: Japan actively efforted to prevent and mitigate natural disasters to protect people's lives and property. In addition to strengthening social infrastructure, Japan makes the most of technology to predict and prevent natural disasters, warning systems, and disaster damage mitigation technologies in eco-smart community development.

From 2011 to 2020, Japan developed four eco-smart communities: Keihanna, Yokohama, Kitakyushu and Toyota. Kitakyushu is the most prominent because of its successful transformation into a typical model of a low-carbon and intelligent community. Therefore, this study will analyse Kitakyushu's innovation experience in developing eco-smart communities. Kitakyushu's eco-smart community is created by six crucial dimensions, namely:

Governance policy

The Japanese government has introduced relevant policies to solve environmental pollution problems toward obtaining symbiosis with nature and building a livable environment. Then, they establish a complete legal guarantee of ecological protection for environmental management and restore the polluted natural environment. From 1967 to 1970, Japan enacted and enforced basic laws about pollution control and action. And the Department of Environment was established in 1971. The basic environment law was promulgated in 1993. Since 2000, "reducing greenhouse gas emissions" has become another focus of environmental protection along with "building a circular society" (Kiji & Peng, 2010), and the "basic law for promoting a recycling society" was enacted. The Kyoto Protocol, signed in 1997 to encourage countries to achieve greenhouse gas emission targets, took effect in 2005. Besides national-level policies, Kitakyushu also has local plans. In 1992, the Kitakyushu Green Basic Plan was formulated, focusing on maintaining trees and parks. In 2000, Kitakyushu launched the new "World Environmental Capital Program". From 2010 to 2015, the construction of eco-smart communities in Kitakyushu was listed as one of the government's new growth strategic areas. The development of smart grids and next-generation transportation systems is the principal means of development in Kitakyushu City. During the 27th Session of the Kitakyushu government, the Environmental Assessment Council formulated the Plan for the Promotion of Low-Carbon City Planning in the central Ogura area, promoting five basic principles and 57 measures. The Kitakyushu Model Eco-Smart Community Action Plan has become one of the leading projects, laying a solid foundation for the Kitakyushu Smart City build.

Transportation

One of the outstanding characteristics of the eco-smart community in Japan and Kitakyushu is the incentive of people to use public transportation and raise environmental awareness to help Kitakyushu's green economy become more competitive in the future. As a result, the Kitakyushu government has improved the quality of public transportation services, renovated train station facilities, bus stops, and utility services, and planned about 1,867 km of bicycle lanes.

Table 1: Transportation improvement measures toward eco-smart communities in Kitakyushu

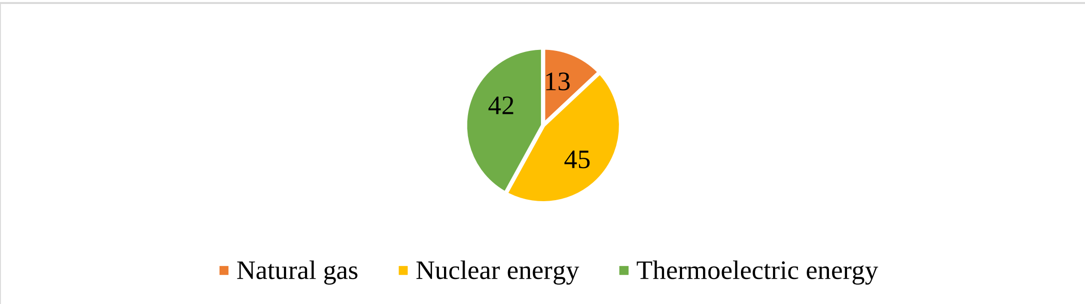
Key measures	Implementation
1. Infrastructure upgrades	Upgrading infrastructure in stations and bus stops to meet the convenience of children and elders
2. Preferential fares	Transfers between stations are subject to a fixed preferential rate of "100 yen"
3. Bus priority	Special bus routes will be opened to improve transportation efficiency
4. Bus upgrades	Lower the height of the door for the disabled and elders. Electric buses are gradually replacing gasoline-powered buses
5. Free parking	The government pays for parking lots near important traffic spots and encourages people to use public transportation
6. Public bicycles	Investment in the deployment of public bicycle locations and bicycle lane planning
7. Promoting clean energy	Many new charging stations are built in residential areas to encourage people to use clean energy

Source: Compiled by the authors

Energy

Kitakyushu is an industrial city, so large-scale industrial energy consumption dominates the energy demand in this area. It is about 66 per cent of the total energy consumption. Therefore, Kitakyushu considers solving the energy supply problem as the key to developing the green economy of Kitakyushu, strengthening energy independence, and realizing the potential to become a low-carbon society.

Figure 2: Proportion of energy sources in Kitakyushu



Source: OECD, 2020

Figure 2 indicated that of the energy supply in Kitakyushu, nuclear power accounts for 45 per cent, thermal power accounts for 42 per cent, and natural gas accounts for 13 per cent. Kitakyushu has launched a price range of 30,000 to 70,000 yen per 1 kWh for the first time to encourage people to install and use solar power systems. Kitakyushu focuses mainly on wind and solar power to promote a new energy generation, thereby changing the energy structure. These actions have demonstrated their efforts to achieve their low-carbon city goals.

Resource recycling

The eco-industrial park in Kitakyushu is divided into the verification research area, the total environmental industrial area, and the Habiki-nada recycling industrial area. Through the "industry - education – research" method, research institutions, businesses, and the Government have come together to treat and recycle various waste products.

Table 2: Characteristics of eco-industrial parks in Kitakyushu

Industrial park	Participants	Characteristic
Verification research area	Businesses, Governments, Universities	Research on waste treatment technology and resource recycling technology
Total environmental industrial area	Home appliance, fluorescent lighting fixture, medical apparatus and other enterprises	Recycling waste to generate electricity
Habiki-nada recycling industrial area	7 automobile demolition plant and small waste treatment plant	Maximum reuse of disassembled car parts

Source: Compiled by authors

The eco-industrial parks in Kitakyushu have implemented 3R measures (reduce, reuse, and recycle) to realize waste recycling and strive to reduce carbon emissions. Kitakyushu has also enacted laws related to waste disposal and cleaning. For instance, enterprises and operators are not allowed to waste paper for destruction (even letters, newspapers, paper bags, and so on). The professional waste paper recycling department will process those papers. The waste recycling industry in Japan's eco-industrial parks is also protected and supported by the household appliance reuse law, the automobile reuse law, and the container packaging reuse law. According to statistics, the factory recovered 85,900 tons of solid waste, accounting for more than 22 per cent.

Community Management

The innovation community of Yahata Higashida in Kitakyushu is one of the symbols of the Ministry of Economy, Trade and Industry to promote a new generation of energy and social systems.

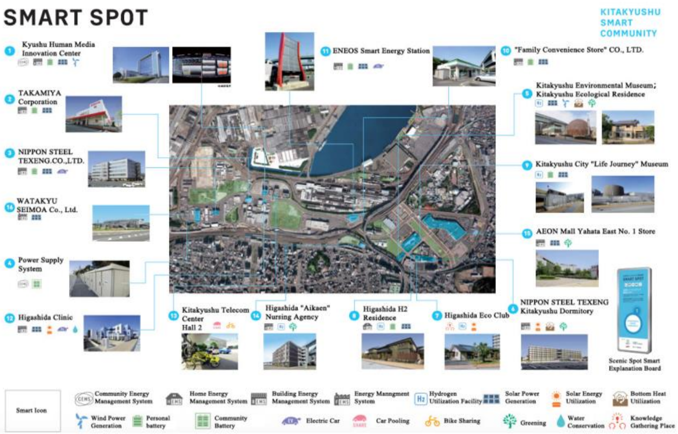


Figure 3: Yahata Higashida intelligent community management system

Source: Brochure of Kitakyushu, 2020

The intelligent community network of Yahata Higashida is divided into a household and a building energy management system. The collection of energy data and the regulation of energy demand management are carried out through smart meters. About 70 enterprises and 200 households in the intelligent community of Yahata Higashida have installed smart meters to monitor energy consumption through the system's real-time data and adjust electricity demand within the appropriate electricity price range to reduce peak electricity consumption.

The Yahata Higashida innovation community has established an energy-saving centre for the community, an eco-point system and carbon offsets, encouraging behaviour to conserve energy and reduce emissions. They control and reduce the energy use of the community, improve the efficiency of new energy supply and demand, and reduce the impact of energy instability on people's jobs and lives by using smartwatches.

Furthermore, the Yahata Higashida community has also built a next-generation transportation system and clean energy such as electricity and hydrogen has become the primary source of transportation consumption. Many charging devices have been introduced into the community to serve new-generation cars and electric bicycles. Through the real-time data analysis of the mass power-saving institute, the total energy of each charging station is distributed as required. The power source of charging equipment mainly comes from clean energy conversion with solar energy and wind energy in the community. Moreover, public transportation in the community is strongly promoted, so people can use convenient transportation by using mobile phones. At the same time, local enterprises, residents, governments, and researchers came together to form the "Yahata Higashida Community Building Joint Meeting" (Gao et al., 2016). Accordingly, residents are encouraged to participate and promote the intellectual and low-carbon development of the Higashida Yahata intelligent community.

4.1.2. China

Like Japan, China's construction of eco-smart communities also selects pilot areas to promote socio-economic development towards sustainable development goals. Bearing similarities to Kitakyushu, Shanghai is one of the best pilot areas in China. Shanghai was planned in 2006 and was conceived by developing a comprehensive transportation hub. In 2010, Shanghai began to build a low-carbon city, and it was rated as China's first three-star national ecological activity city in 2018. Shanghai's economic development and environmental protection are balanced through measures, namely:

Energy

Shanghai has built five power stations to meet the energy needs of air conditioning and water supply systems. The overall energy and thermal power decreased significantly, and the unit area decreased by 12.53 kWh/m^2 due to the implementation of green operation management measures. In recent years, electricity output has been strong. In general, energy consumption in urban areas is decreasing, and the effect of saving energy and reducing emissions is distinct. According to the statistics, the annual energy consumption in Shanghai was more than 200,000 MWh in 2018.

Transportation

Shanghai designed overpasses and underground walkways to improve the pedestrian system, and the three-way traffic coverage rate reached 100 per cent. Public transport connects Shanghai's inner-city and suburban roads and important interchanges for efficient mobility. Shanghai focuses on public transport solutions like densely arranged public bicycles and increased frequency of bus systems during morning and evening rush hours. The general transportation system provides sufficient conditions for people's mobility needs with low carbon content.

Table 3: Characteristics of the ecological transportation system in Shanghai

Overpass system	Connecting the North-South pedestrian system and adding a road network to create a continuous space for pedestrians
Underground systems	Connect to essential intersections and quickly evacuate people during peak hours
Public transport	Set up many bus stops within a 45-minute travel range, and motor vehicle lanes cover the entire road
Shared transportation	Establish public bicycle rental services within 300-400 m and increase public buses during morning and evening rush hours
Green streets	Relying on the natural landscape to build a slow-moving system

Source: Compiled by authors

Building Management

The Shanghai government requires buildings to achieve the goal of managing low carbon emissions and saving energy throughout their life cycle. Determine the green building level according to the location and attributes of the building in the planning and design stage. Divide responsibilities and organize regular acceptance during construction. Building information data is connected to an energy-efficient, low-carbon operation management platform during the operation stage. Summarize water, electricity, and energy consumption data in the area, and verify and evaluate the energy consumption of buildings to achieve energy conservation and emission reduction goals. By 2019, more than 300 buildings were connected to the Shanghai government's energy platform.

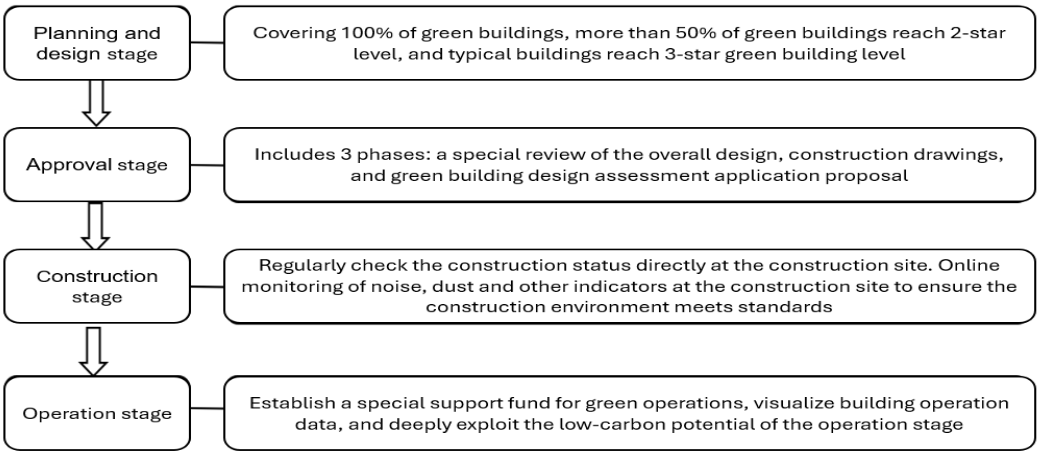


Figure 4: The process of managing green buildings in Shanghai

Source: Compiled by authors

Ecological environment

To save energy and reduce emissions, we must build an ecological environment. The ecological environment in Shanghai includes river systems and landscape greenery. For the water system, each river is divided into each person responsible for implementing "one river, one policy", ultimately bringing the overall water quality to national standards. For landscape greening, roof greening is widely used in urban works, with a coverage rate of over 50 per cent. Divide the right to manage green space for enterprises so that they are responsible for building the environment and improving environmental quality.

In general, the Shanghai Hongqiao eco-smart community has effectively reduced raw energy consumption in urban operations through centralized energy supply to the region and green building rating. At the same time, low-carbon transportation and the natural environment have raised awareness of people's environmental protection. Building various intelligent platforms also avoids wasting energy. However, the eco-smart community construction in Shanghai is mainly managed from the top down, lacking timely feedback and cooperation from the people.

4.2. Suggestions for Kien Giang province

Governments of countries recognise that access to intelligent solutions plays a crucial role in eco-smart community development in all countries. Through the analysis of the eco-smart community of Kitakyushu (Japan) and Shanghai (China), Kien Giang can and needs to learn from the experiences of Kitakyushu and Shanghai in building and developing eco-smart communities in the future. The lessons learned from the process of eco-smart community development in Kitakyushu and Shanghai have suggested the next direction for Kien Giang in its efforts to continue building and developing eco-smart communities, namely:

Firstly, the experience from Kitakyushu and Shanghai shows the need to develop a modern and connected public transportation network. The transport infrastructure system and public transport are not well in Kien Giang province. The above development requires a lot of time and resources. Therefore, Kien Giang province needs to attract investment from private enterprises and foreign enterprises to develop modern infrastructure systems and public transport services and increase connectivity between localities in the province, thereby attracting people and tourists to use, leading to a reduction in carbon emissions, and towards the formation of an eco-smart community. For this solution to be highly feasible, it should be implemented with close cooperation between local authorities, enterprises and local people and combined with long-term strategic plans.

Secondly, the experience of Kitakyushu and Shanghai both shows that energy solutions are one of the crucial facets of creating an eco-smart community. Kien Giang has much potential to develop renewable energy because it is located in an area with a high number of sunshine hours from 2,200 to 2,500 hours/year, an average of 1,733 - 1,846 sunshine hours/year, and an average radiation intensity of 4.74 - 5.05 kWh/m^2/day, which is ideal conditions for solar power development. At the same time, Kien Giang is a coastal province with an average wind speed of not high, about 5-7 m/s at an altitude of 100-160m, but stable, so it is also a potential for exploitation and development of wind energy. However, the province's renewable energy development situation is still not proportional to available potential. Therefore, Kien Giang province needs to attract businesses and projects to invest in renewable energy and encourage people to convert, install and use renewable energy sources to replace traditional energy in the coming time. For this solution to be highly feasible, it is necessary to have a master plan for renewable energy development to make the most of the available potential and solve infrastructure, finance and awareness challenges.

Thirdly, Kien Giang is one of the provinces with a large concentration of industrial parks in the Mekong Delta. Therefore, Kitakyushu's experience shows that Kien Giang needs to build eco-industrial parks. Eco-industrial parks are an effective solution to create eco-smart communities. Accordingly, in existing industrial parks, Kien Giang province needs to divide areas that do not affect the natural environment and the community, apply green building standards, or use environmentally friendly materials. In addition, it is necessary to build systems for collecting, classifying, and recycling industrial waste. At the same time, enterprises are encouraged to use production technologies that are less polluting and save resources. For this solution to be highly feasible, the Kien Giang provincial government needs a master planning strategy and specific policies on eco-industrial park development.

5. Conclusion

The era of Industry 4.0 is considered a modern trend and brings many opportunities for comprehensive development in all aspects of economic, social life and environmental protection. Developing an eco-smart community model to improve the quality of people's lives is the orientation and goal of localities. Therefore, to build an eco-smart community, learning from international experiences from Japan and China will promote the inherent advantages, limiting difficulties and losses arising in developing an eco-smart community, thereby bringing comprehensive benefits to the community as economy, society and environment.

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Exploring the Complex Legal Landscapes of Travel and Tourism: Lessons for Vietnam

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Abstract

This paper aims to analyze and propose enhancements to the legal framework governing the travel and tourism sector in Vietnam. The study employs a comprehensive review of existing literature and international legal frameworks to identify key regulatory gaps and challenges in Vietnam's tourism industry. The findings highlight the necessity for Vietnam to develop detailed regulations on business operations, enhance consumer protection, and regular regulations. This paper contributes to the literature by offering recommendations to strengthen Vietnam's legal framework for tourism, aiming to foster sustainable growth in the tourism sector.

Keywords: *Tourism business, legal framework, consumer protection, regulatory frameworks, sustainable development*

1. Introduction

The travel and tourism industry plays a pivotal role in the global economy, contributing significantly to job creation, economic growth, and cultural exchange. In 2019 alone, this sector contributed 10.4% to global GDP and supported 319 million jobs, equating to 10% of worldwide employment (Savan et al., 2020). These statistics underscore the sector's importance not just in economic terms, but also in advancing related industries such as transportation, hospitality, retail, and entertainment. Despite its economic significance, the industry faces numerous challenges that necessitate strong legal and regulatory frameworks to ensure its sustainable development (Higgins-Desbiolles, 2020).

The COVID-19 pandemic has laid bare many of these vulnerabilities, highlighting the urgent need for resilient legal frameworks that can manage crises and support recovery (Cheer et al., 2021; Higgins-Desbiolles, 2020). A robust legal framework is indispensable for effectively managing tourism businesses. It establishes clear guidelines for operations, including licensing, safety, and service standards, thereby ensuring fairness and enhancing service quality. Furthermore, such frameworks protect consumer rights through transparency and mechanisms for addressing service failures or disputes, fostering trust and supporting sustainable growth within the sector.

In the context of Vietnam, the need for a well-defined legal framework becomes even more pressing as these countries work towards achieving net zero emissions and promoting sustainable development. A comprehensive legal approach is critical for enforcing sustainable tourism practices, which are essential for conserving natural and cultural heritage. Without responsible management, tourism can contribute to environmental degradation, cultural erosion, and social displacement. Regulations that cap tourist numbers in sensitive areas, promote eco-friendly accommodations, and encourage responsible behavior from both tourists and operators are essential in mitigating these risks.

The focus of this paper is to explore how legal frameworks can be designed and implemented to support sustainable tourism practices within the context of net zero emissions goals. While promoting green and responsible tourism is a recognized concern globally, including in Vietnam, the specific contribution of this study lies in its examination of how legal frameworks can effectively integrate sustainability principles into tourism practices. By adopting international best practices, Vietnam can develop a robust legal framework that not only supports a resilient and thriving tourism sector but also contributes positively to national economic goals and the advancement of sustainable development objectives. This paper will critically analyze the existing legal frameworks, propose improvements, and discuss their implications for achieving net zero emissions in the tourism sector.

2. Literature review

The travel and tourism sector functions within a multifaceted framework of legal regulations that govern business practices, ensure compliance, and protect consumers. This section delves into the fundamental aspects of global legal frameworks that oversee the travel and tourism industry (Mensah & Boakye, 2023; Rastegar et al., 2021; Tien et al., 2021). By drawing on recent scholarly contributions, it elucidates the intricate interplay between legislative mandates, regulatory oversight, and industry standards. Through this lens, stakeholders can grasp the holistic panorama of legal frameworks that underpin the industry's operational landscape. The travel and tourism industry functions within a multifaceted regulatory environment characterized by numerous legal frameworks aimed at overseeing various aspects of business operations, ensuring consumer protection, and promoting sustainable practices (Roblek et al., 2021; Streimikiene et al., 2021). This literature review offers an overview of existing scholarship related to legal frameworks in the travel and tourism sector, providing insights into key themes, regulatory challenges, and best practices.

Regulatory frameworks

Scholarly literature emphasizes the importance of regulatory frameworks and licensing requirements in shaping the operations of the travel and tourism industry. Regulations regarding registration and licensing in the tourism sector are crucial for managing and overseeing tourism activities (Didenko et al., 2022; Huang, 2016). Businesses, organizations, or individuals wishing to operate in the tourism sector must comply with the registration process and obtain a license from the competent authorities. Regulatory frameworks encompass a wide array of laws, regulations, and policies governing tourism activities, including business registration, licensing procedures, and compliance standards (Mutana & Mukwada, 2020; Park, 2020). This process typically involves submitting a prescribed application form, providing relevant documents, and demonstrating the ability to organize and operate tourism services safely and with quality. Competent authorities then conduct a review and assessment of the application and decide on the issuance of a license based on specified criteria and conditions. Ensuring compliance with registration and licensing regulations not only ensures professionalism and safety in tourism activities but also plays a crucial role in protecting the rights of tourists and promoting the sustainable development of the tourism industry.

Consumer protection

Consumer protection emerges as a critical theme in the literature on legal frameworks in the travel and tourism industry (Alhemimah, 2023; Zhou et al., 2022). Protecting tourists is a core task in the tourism industry, playing an undeniable role in promoting sustainable development and economic stability. This involves ensuring physical safety for tourists and preparing thoroughly regarding risk information, implementing stringent safety measures, and providing reliable emergency services. Comprehensive training for tourism staff is crucial for efficiently handling various emergency situations, from medical to security incidents. Moreover, close collaboration among local authorities, tourism businesses, and the local community is pivotal in creating a safe environment for tourists (Bichler, 2021; Bramwell & Lane, 2000; Musavengane & Kloppers, 2020). Enhancing the safety and well-being of tourists strengthens the destination's reputation, fostering trust and encouraging tourism growth. Academic research underscores the significant role of prioritizing tourist protection, contributing to flexibility and satisfaction among tourists, thus laying the foundation for the sustainable development of the tourism industry in the long term.

Enforcement mechanisms

Enforcement mechanisms represent significant areas of concern in the literature on legal frameworks in the travel and tourism industry (Wong & Lai, 2021). These mechanisms are essential for ensuring order and safety for tourists and protecting the interests of all stakeholders involved. They include measures and procedures established to monitor and enforce compliance with regulations and rules in tourism activities. One of the main mechanisms is the enforcement of regulations regarding the quality of tourism services (B. Nguyen, 2022; Özgit & Akanyeti, 2022). Businesses and organizations operating in the tourism industry must adhere to standards and regulations related to hygiene, safety, service, and relevant legal requirements. Tourism management and supervisory authorities conduct inspections, monitoring, and certification to ensure compliance with these regulations. Inspection measures may include document checks, safety and hygiene inspections, or regular audits. Furthermore, enforcement mechanisms involve handling violations and applying disciplinary measures against businesses, organizations, or individuals who breach regulations (Budiartha et al., 2022; Hua et al., 2020; Li & Chen, 2022). These measures may include fines, revocation of licenses, or temporary bans from operating in the tourism industry.

This paper provides a comprehensive picture of the laws that affect travel and tourism, highlighting important themes and challenges. It underscores the need for strong legal frameworks to ensure tourism is responsible, sustainable, and resilient. Regulatory frameworks and licensing requirements play a crucial role in shaping industry operations, ensuring consumer protection, and promoting sustainable practices (Roblek et al., 2021; Streimikiene et al., 2021). Consumer protection measures enhance trust and confidence among travelers, while sustainability initiatives and environmental regulations aim to mitigate the industry's environmental impact. Enforcement mechanisms and compliance challenges represent ongoing areas of concern, requiring concerted efforts from regulatory authorities, industry stakeholders, and policymakers to address effectively. Overall, the literature emphasizes the significance of legal frameworks in promoting a responsible and sustainable tourism industry.

3. Methods

The research employs a comparative legal approach, which involves a systematic comparison of legal frameworks across different countries. This method is particularly effective in identifying best practices, regulatory gaps, and opportunities for harmonization in the travel and tourism sector. The following sections outline the key components of this comparative analysis. The study focuses on several developed countries and Asia countries, including United States, European Union, Japan, Australia, Singapore, Malaysia, Thailand, Indonesia, and The Philippines. These countries were selected based on their significant tourism industries, diverse legal frameworks, and varying levels of economic development. This selection allows for a comprehensive analysis of different regulatory approaches within the region This multi-source approach ensures a thorough understanding of the legal landscapes in each country. By identifying commonalities and disparities, the study offers valuable insights for enhancing regulatory practices, promoting sustainable tourism, and protecting consumer rights in Vietnam.

4. Results

4.1. International experiences in legal frameworks for the travel and tourism business

4.1. Legal frameworks in developed countries

United States

The legal frameworks governing the travel and tourism business in the United States are complex and multi-layered, encompassing federal, state, and local regulations (Holmes, 2020; Martínez et al., 2021). Key legal frameworks from various federal regulations, such as those enforced by the Department of Transportation through the Federal Aviation Administration, which regulates air travel, and the Surface Transportation Board and National Highway Traffic Safety Administration, which oversee rail, bus, and vehicle safety standards. The Department of Homeland Security plays a significant role through the Transportation Security Administration and U.S. Customs and Border Protection, ensuring traveler security and managing entry into the U.S. The Federal Trade Commission enforces consumer protection laws to prevent fraud in travel marketing, while the Department of State issues passports and oversees international travel regulations. The Centers for Disease Control and Prevention sets health guidelines for travelers. State regulations are enforced by state tourism offices, consumer protection agencies, and transportation departments, each addressing state-specific tourism and travel service issues. Local regulations involve municipal and county laws affecting zoning, health and safety codes, and local tourism taxes. Industry-specific regulations cover travel agencies, hotels, resorts, and cruise lines, with laws like the Americans with Disabilities Act and Occupational Safety and Health Administration standards ensuring accessibility and safety. International regulations, such as the Visa Waiver Program and various bilateral agreements, facilitate travel to the U.S. Compliance and enforcement are upheld through consumer protection laws and environmental regulations, ensuring accurate service information and the protection of natural resources. The U.S. travel and tourism industry operates under this comprehensive legal framework to ensure safety, protect consumers, and promote fair business practices.

European Union

The legal framework governing the travel and tourism business in the European Union is comprehensive and involves various regulations and directives designed to ensure safety, consumer protection, and fair business practices (Riefa & Saintier, 2020; Weatherill, 2013), such as the Package Travel Directive (2015/2302/EU) for consumer protection in package holidays, the Unfair Commercial Practices Directive (2005/29/EC) for dispute resolution. Transportation regulations like the Air Passenger Rights Regulation (EC No 261/2004) and similar regulations for rail, maritime, and bus transport ensure passenger rights. Health and safety standards are maintained through the GDPR (EU 2016/679) for data protection and food safety regulations. Accessibility is improved by the European Accessibility Act (2019) and directives ensuring accessibility of public sector websites and apps. National regulations involve country-specific consumer protection laws, tourism promotion, and health and safety codes, while local regulations include zoning laws, tourism taxes, and licensing requirements. Industry-specific regulations require travel agencies to comply with the Package Travel Directive and hospitality businesses to adhere to EU-wide health, safety, and GDPR standards. International agreements like the Schengen Agreement facilitate visa-free travel, and bilateral agreements simplify visa processes. Compliance and enforcement are managed by the European Consumer Centres Network (ECC-Net), national enforcement bodies, and the European Court of Justice (ECJ), ensuring the uniform application of EU laws across member states. This detailed legal framework is essential for maintaining trust and smooth operations in the EU travel and tourism industry.

Japan

The legal framework governing the travel and tourism business in Japan is multifaceted, incorporating national laws, regulations, and guidelines aimed at ensuring safety, consumer protection, and sustainable tourism practices (Romão, 2018; Su et al., 2022). Key legal regulation is the Travel Agency Act, which requires travel agencies to register and adhere to standards that protect consumer rights and ensure financial stability. The Hotel Business Act sets standards for the operation and licensing of accommodation facilities, ensuring safety, hygiene, and accessibility. Consumer protection is further reinforced by the Consumer Contract Act, which addresses unfair business practices and provides recourse for consumers. The Road Transport Act regulates the safety and operation of buses, taxis, and other tourist transport services. Additionally, Japan has implemented measures to promote sustainable tourism, such as the Basic Act on the Promotion of Tourism, which aims to enhance the tourism experience while preserving cultural and natural resources. Local regulations, including zoning laws and environmental guidelines, also play a significant role in managing the impact of tourism on communities and the environment. Compliance with these regulations is overseen by various governmental bodies, ensuring that the tourism industry operates smoothly and responsibly.

Australia

The legal framework governing the travel and tourism business in Australia is comprehensive, involving a combination of federal, state, and local regulations designed to ensure consumer protection, safety, and sustainable tourism practices (Techera & Klein, 2013). At the federal level, the Australian Consumer Law (ACL) provides broad protections against unfair business practices and ensures accurate information and fair contracts for consumers. The Travel Agents Act, administered by individual states and territories, requires travel agents to be licensed and adhere to financial security requirements to safeguard consumer funds. The Australian Tourism Accreditation Program (ATAP) promotes high standards of service and operational practices within the industry. Additionally, the Environment

Protection and Biodiversity Conservation Act (EPBC Act) ensures that tourism activities comply with environmental standards to protect Australia's natural heritage. Health and safety regulations, such as those set by Safe Work Australia, ensure the safety of employees and tourists alike. Local governments also impose zoning laws, licensing requirements, and environmental regulations specific to their regions, addressing the unique needs and impacts of tourism in different areas. Compliance and enforcement are carried out by various agencies to ensure that the tourism industry operates ethically, safely, and sustainably.

4.2. Legal frameworks in Asian countries

Singapore

Singapore is known for its rigorous and efficient regulatory framework in the travel and tourism sector (Dmitrieva et al., 2020; Ho & Tan, 2021). The Travel Agents Act and the Travel Agents Regulations mandate that all travel agents obtain a license from the Singapore Tourism Board. The licensing criteria include financial solvency, professional qualifications, and the maintenance of a security deposit to safeguard consumer interests. Singapore's Consumer Protection Act also plays a critical role, ensuring that consumers are protected against unfair trade practices.

Malaysia

Malaysia's tourism sector is regulated by the Tourism Industry Act 1992, which governs the registration, licensing, and conduct of tourism-related businesses (Abd Hamid & Isa, 2020; Mohd Zahir et al., 2021). The Ministry of Tourism, Arts, and Culture Malaysia oversees the implementation of this act. Travel agencies must obtain a license and meet criteria related to financial stability and professional competency. Consumer protection is enhanced through the Consumer Protection Act 1999, which ensures transparency and fairness in business practices. Malaysia also emphasizes sustainable tourism, with initiatives promoting eco-tourism and responsible travel practices.

Thailand

Thailand has the Tourism Business and Guide Act, Tourism Business Law, established in 1952, which also talks about how travel agencies, tour operators, and guides need to be registered and licensed (Khunphasee & Wongbandit, 2022; Wirudchawong, 2012). The Department of Tourism oversees the implementation of this act, ensuring that businesses meet specific criteria related to financial health, professional qualifications, and ethical conduct. Consumer protection is a significant aspect of Thailand's legal framework, with regulations requiring clear communication of tour prices, itineraries, and cancellation policies. The Tourism Business and Guide Act also provides for the establishment of a tourism fund to compensate tourists in cases of business insolvency or other disputes, thereby enhancing consumer confidence and industry stability.

Indonesia

Indonesia's legal framework for the travel and tourism industry is governed by the Tourism Law No. 10 of 2009. This law outlines the requirements for business registration, licensing, and the conduct of tourism enterprises. The Ministry of Tourism and Creative Economy oversees the implementation of these regulations. Travel agencies must meet criteria related to financial health, professional qualifications, and consumer protection. The Consumer Protection Act No. 8 of 1999 further safeguards consumer rights, ensuring transparency and fair business practices. Indonesia also promotes sustainable tourism through various initiatives aimed at preserving natural and cultural heritage (Hampton & Clifton, 2016; Towner & Davies, 2019).

The Philippines

The Philippines' tourism industry is regulated by the Tourism Act of 2009, which provides a comprehensive framework for the development and management of tourism enterprises. The Department of Tourism oversees the implementation of this law, ensuring that travel agencies and tour operators obtain the necessary licenses and comply with regulatory standards (Dela Santa & Saporsantos, 2016; Javier & Elazigue, 2011). Consumer protection is addressed through the Consumer

Act of the Philippines, which mandates transparency and fairness in business practices. The Philippines also promotes sustainable tourism through various programs aimed at environmental conservation and community engagement.

4.3. Recommendations for Vietnam

Vietnam's tourism sector is regulated by the Law on Tourism, which was amended in 2017 to address the growing needs of the industry. This law requires all tourism businesses, including travel agencies and tour operators, to register with the Ministry of Culture, Sports, and Tourism and obtain necessary licenses. The law also emphasizes consumer protection, mandating clear and truthful information about services and prices. Vietnam promotes sustainable tourism through policies encouraging eco-friendly accommodations and responsible travel practices, reflecting its commitment to preserving natural and cultural resources (Lisha & Abdullah, 2021; P. M. Nguyen et al., 2022). Vietnam has seen rapid growth in its tourism sector, making it imperative to develop a robust legal framework to sustain this growth and address emerging challenges.

Current legal structures in Vietnam need enhancement to cover various aspects of tourism management comprehensively. This includes detailed regulations on business operations, consumer protection measures, and sustainability guidelines. Vietnam should learn from international experiences to improve its legal framework for the travel and tourism business. The legal framework for the travel and tourism sector in Vietnam would benefit from the development of detailed and specific regulations concerning the registration and operation of businesses. Clear guidelines and requirements would ensure that companies operate within a well-defined legal structure, promoting transparency and accountability in the industry. Additionally, enhancing customer protection is crucial, which could be achieved through the implementation of robust insurance measures and the establishment of customer protection funds. These initiatives would provide a safety net for travelers, ensuring they are adequately protected in case of disputes or emergencies. Moreover, it is essential to regularly update and refine these regulations to keep pace with the evolving market demands. The travel and tourism industry is dynamic, with new trends and challenges emerging continuously. By periodically reviewing and amending the legal framework, Vietnam can ensure that its regulations remain relevant and effective in addressing contemporary issues. This proactive approach will help maintain a competitive and sustainable tourism sector, fostering trust and confidence among both businesses and consumers.

5. Conclusion

The travel and tourism sector is a vital component of the global economy, significantly contributing to GDP, job creation, and cultural exchange. However, the industry faces numerous challenges that necessitate robust legal and regulatory frameworks to ensure its sustainable growth and resilience, particularly in the context of achieving Net Zero Emissions and Sustainable Development. These frameworks are crucial for establishing clear operational guidelines, protecting consumer rights, and promoting sustainable tourism practices. The COVID-19 pandemic has highlighted the vulnerabilities of the tourism sector, emphasizing the need for comprehensive legal structures to navigate crises and support recovery while aligning with sustainability goals.

A well-developed legal framework is essential for the orderly operation of tourism businesses. It ensures that enterprises meet licensing and registration requirements, comply with safety and service standards, and operate transparently. This not only fosters a competitive and trustworthy industry but also enhances the quality and reliability of tourism services. Protecting consumer rights is another critical aspect, involving transparency in pricing, truthful advertising, and effective mechanisms for addressing service failures or disputes. Such measures build consumer trust and confidence, which are vital for the sector's long-term sustainability.

Furthermore, addressing the need for sustainable tourism practices is paramount in the context of Net Zero Emissions. Legal regulations can enforce measures to reduce the carbon footprint of tourism activities, such as promoting energy-efficient accommodations, supporting low-emission transportation options, and encouraging sustainable practices among tourists and operators. Regulations can also include initiatives to preserve natural and cultural heritage, limit tourist numbers in ecologically sensitive areas, and foster the use of eco-friendly technologies. These actions are critical for mitigating the negative environmental and social impacts of tourism, ensuring that it contributes positively to local communities and ecosystems while working towards Net Zero Emissions goals.

In the context of Vietnam, current legal structures need enhancement to comprehensively address these sustainability challenges. Developing detailed regulations on business operations, consumer protection, and sustainability is essential. By incorporating international best practices, Vietnam can refine its legal framework to better align with Net Zero Emissions targets and evolving market demands. Regular updates and refinements of regulations are crucial to keep pace with new trends and challenges. By adopting a proactive approach, Vietnam can foster a competitive, transparent, and sustainable tourism sector that significantly contributes to the national economy and supports global sustainability efforts.

In general, the importance of legal frameworks in promoting a responsible, resilient, and environmentally sustainable tourism industry cannot be overstated. Through clear guidelines, consumer protection measures, and sustainable practices, these frameworks ensure that the travel and tourism sector remains a major driver of economic growth and cultural exchange while advancing Net Zero Emissions and Sustainable Development goals and safeguarding the interests of all stakeholders involved.

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Legal Framework for Patent Protection of Green Technologies in Vietnam

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Abstract

This paper explores green technologies and their implications for sustainable development in Vietnam, focusing on the role of patent in advancing green innovations. It analyzes the legal current state of patent protection for green technologies in Vietnam, evaluating how existing policies support or hinder the development and dissemination of these technologies. The research method combines regulatory analysis and comparative analysis. Regulatory analysis assesses Vietnam's patent laws and policies, examining their alignment with international standards and effectiveness in fostering green technologies.

The study uses data from legislative texts, policy reports, and case studies of green patents. Key findings suggest that Vietnam's patent framework has not yet developed a specialized structure for the protection of green technologies. Existing challenges include ambiguous definitions of green technologies, insufficient classification systems, issues related to commercial exploitation and transferability, and limited technological collaboration capacity. The paper concludes with recommendations to improve Vietnam's patent system concerning green technologies. Suggested enhancements include establishing clearer definitions and classifications for green technologies, bolstering support for patenting procedures, facilitating the commercial exploitation of patents, and fostering greater international collaboration. These measures aim to refine the legal framework, advance sustainable development, and promote the proliferation of green technologies within Vietnam through an optimized patent system.

Keywords: *Green technologies, innovation, patent, sustainable development*

1. Introduction

Vietnam has pledged to achieve net-zero emissions by 2050, a commitment that necessitates substantial progress in green technology development. As Vietnam navigates its transition to a low-carbon economy, green technologies will play a pivotal role in mitigating greenhouse gas emissions, enhancing energy efficiency, and promoting sustainable development practices.

The advancement and deployment of green technologies are significantly influenced by the legal framework governing patent protection. A well-structured patent regime is essential for safeguarding intellectual property rights, fostering innovation, and facilitating the commercialization of green technologies. Effective patent laws not only provide legal protection but also create an environment that incentivizes research and development by ensuring that innovations are adequately protected and rewarded.

To support the growth of green technologies, it is imperative to scrutinize Vietnam's current patent legislation and its impact on green technology innovation. This analysis will involve evaluating the existing legal mechanisms, identifying potential gaps or inefficiencies, and considering reforms that could enhance the patent protection framework. By refining the legal infrastructure for patents, Vietnam can better support its green technology sector, thereby advancing its net-zero emissions objectives and reinforcing its position as a leader in sustainable innovation.

The research established two main objectives: i) Assessing the effectiveness of Vietnam's current patent legal framework in protecting intellectual property rights and commercializing green technologies, and to identify any gaps or inefficiencies within the existing system; ii) Suggesting legislative enhancements that can address the identified gaps and improve the effectiveness of patent protection for green technologies, thereby supporting innovation and Vietnam's net-zero emissions goals.

2. Literature review and Theoretical framework

Several seminal studies have examined the relationship between patents and green technologies.

"Green innovations and patenting renewable energy technologies", Esfandiar Maasoumi, Almas Heshmati and Inhee Lee (2020). This study analyzes how regulations and policies affect green patent generation and the evolution of renewable energy technologies across OECD countries. However, since the study focuses on OECD countries, developing nations like Vietnam are not addressed;

"Developing and Diffusing Green Technologies: The Impact of Intellectual Property Rights and their Justification", Jonathan M.W.W. Chu (2012). This paper explores how intellectual property rights influence the development and diffusion of green technologies. However, the author addresses the overall impact of intellectual property rights on green technologies, not just focusing exclusively on patents.

"Patent Landscape on Green Technology in Vietnam", Chris Vale, Duong Vu (2021). This is a rare research study that directly examines green technologies and green patents in Vietnam. However, it primarily focuses on statistical analysis of the number of green patents, without addressing the associated policies, patent laws, or their impact on green patents and green technologies.

This study offers a contribution by focusing specifically on Vietnam's legal and policy environment for green patents. Unlike previous research, it integrates both legal and policy dimensions, identifies specific gaps in the current system, and provides targeted recommendations for improvement. This approach addresses the unique challenges faced by Vietnam, offering new insights and actionable solutions for enhancing patent protection for green technologies.

The research is grounded in the primary theoretical framework of intellectual property, which asserts that intellectual property rights, particularly patents, are instrumental in fostering innovation by providing inventors with exclusive rights to their creations. This exclusivity serves as a catalyst for investment in research and development, thereby promoting technological progress, including advancements in green technologies. Complementing this, management theory assesses the impact of various regulatory frameworks, including patent laws, on the innovation and dissemination of green technologies. This theoretical perspective aids in understanding how regulatory adjustments can either facilitate or obstruct the advancement and adoption of green technologies.

3. Methods

The research team employ a multifaceted research methodology in order to thoroughly examine the the effectiveness of patent protection and its impact on green technologies in Vietnam. This approach should integrate both regulatory and comparative analyses to provide a comprehensive evaluation of the current legal environment and its effectiveness:

i) Method regulatory analysis involves a detailed examination of the existing laws and regulations related to the patent protection of green technologies in Vietnam. It includes an assessment of the current legal framework, identifying strengths, weaknesses, and gaps in the legislation. The analysis focuses on how effectively the existing regulations support or hinder the development of green technologies;

ii) Method comparative analysis entails comparing Vietnam's legal framework with those of other jurisdictions that are recognized for their advanced patent protection systems for green technologies. By evaluating the practices, policies, and regulatory approaches of these jurisdictions, insights can be gained into best practices and potential improvements for Vietnam's legal framework. This comparison helps identify successful strategies and mechanisms that could be adapted to enhance Vietnam's own regulatory environment.

4. Results

4.1. Green technologies and its implications for sustainable development in Vietnam

Green technologies (greentech) are considered a crucial factor in the process of mitigating climate change, contribute to environmental sustainability, as defined under various international agreements, including the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. Achieving substantial reductions in carbon emissions is critical, and this can be realized through two primary avenues. The first is enhancing energy efficiency by reducing the amount of energy required to produce each unit of output. This approach ensures that less energy is consumed overall, contributing directly to emission reductions. The second, equally important, strategy is the development and adoption of new technologies designed to lower the amount of carbon emitted per unit of energy consumed, thereby improving what is referred to as carbon efficiency (David, 2012). These dual strategies - energy efficiency and carbon efficiency - offer a pathway to meaningful emission reductions without hindering economic productivity. They are essential components in the global effort to combat climate change, as they enable industries to reduce their environmental impact while maintaining, or even enhancing, their output. Importantly, these strategies can be implemented across a wide range of sectors, from manufacturing and transportation to agriculture and energy production, making them versatile tools in addressing the broader climate crisis. An alternative approach that has been suggested involves reducing overall emissions by curtailing total economic activity. While this method could theoretically lower emissions, it presents significant challenges, particularly for developing nations (David, 2012). Given these considerations, the most practical and effective solution lies in the continued development and global dissemination of technologies that improve both energy and carbon efficiency. By fostering innovation in greentech, countries can simultaneously promote economic growth and environmental sustainability. This technological advancement offers a path that allows developing nations to grow and prosper without being forced to choose between economic progress and environmental responsibility.

Agenda 21 of the United Nations Conference on Environment and Development, Chapter 34, identifies green technologies under the term “environmentally sound technologies” as having the capacity to protect the environment, cause less pollution, use resources more sustainably, and handle waste more effectively compared to older technologies. This includes technologies that generate minimal or no waste and those that address existing pollution. It also emphasizes the importance of technology transfer and collaboration through supportive measures to promote these advancements (UN, 1992). According to the World Intellectual Property Organization (WIPO), greentech refers to sustainable technologies aimed at reducing environmental impacts. WIPO recognizes green technologies as crucial for addressing global challenges such as climate change, pollution, and resource depletion. These technologies are designed to be environmentally friendly and support sustainable development (WIPO, 2021). WIPO also developed The IPC Green Inventory - a specialized subset of the international patent classification system designed to categorize and facilitate access to patent information related to environmentally sound technologies. The IPC Green Inventory covers technologies across various categories, including: i) Alternative energy production; ii) Energy conservation; iii) Transportation; iv) Waste management; v) Agriculture and forestry; vi) Water conservation (WIPO, 2023). The IPC Green Inventory is aimed at promoting transparency and accessibility to intellectual property rights related to green technologies. It helps streamline the search process for patents that address issues such as climate change, pollution control, and resource conservation, and it plays a role in fostering the development and dissemination of green technologies globally.

Green technologies is also a component of the Sustainable Development Goals (SDGs), which were adopted by all United Nations Member States in 2015 as part of the 2030 Agenda for Sustainable Development (UN, 2015). Greentech will contribute to: i) Mitigating climate change through clean energy: The expansion of renewable energy, mandated by SDG 7, directly contributes to the reduction of greenhouse gas emissions, which is central to SDG 13. Green technologies that generate clean energy (e.g., solar, wind, and geothermal) are critical to meeting the climate targets set under international legal agreements like the Paris Agreement; ii) Energy efficiency and climate mitigation: Regulatory frameworks that promote energy efficiency, a key component of SDG 7, help reduce energy consumption and thus emissions, in line with SDG 13. Legal mechanisms such as energy performance standards and efficiency labeling requirements for appliances, buildings, and vehicles foster the adoption of green technologies that reduce both energy use and environmental impacts; iii) Technology transfer and international cooperation: The legal framework of the Paris Agreement emphasizes the importance of technology transfer, particularly in the context of SDG 13. Developed countries are legally obligated to assist developing nations in acquiring and deploying green technologies. This technology transfer is essential for advancing both clean energy solutions (SDG 7) and climate action (SDG 13) (Ishmael, 2016).

Vietnam has been a signatory to the UNFCCC since 1994 and ratified the Paris Agreement in 2016 (Oliver, 2019). In accordance with its commitments under the Paris Agreement, Vietnam has pledged to reduce greenhouse gas emissions by 9% by 2030 using domestic resources, with the potential to increase this reduction to 27% contingent upon receiving international support. The country prioritizes climate adaptation, particularly in agriculture, water management, and disaster resilience. Vietnam is advancing its legal and regulatory frameworks to support the development of renewable energy and improve energy efficiency, with a legally binding target of achieving net-zero emissions by 2050. Nonetheless, Vietnam faces significant challenges, including financial constraints and a heavy dependence on coal, which necessitate continued international assistance and comprehensive policy reforms to fulfill its climate objectives.

In the roadmap for achieving these goals, the Vietnamese government recognizes the importance of green technologies. This is specifically addressed in:

- Decision No. 1658/QD-TTg dated October 01, 2021 by the Prime Minister approval for National Green Growth Strategy for 2021 - 2030 with a vision by 2050: emphasize the development and adoption of advanced technologies that drive economic growth while reducing environmental impact such as renewable energy technologies, technologies that improve energy efficiency, supporting the research, development, and commercialization of innovative green technologies;
- Decision No. 2068/QD-TTg dated November 25, 2015 by the Prime Minister approval the Vietnam Renewable Energy Development Strategy by 2030 with a vision by 2050: technology is pivotal for transitioning to a low-carbon energy system. It enhances energy efficiency through advanced renewable technologies and energy management systems. Technology expands renewable energy capacity with innovations in solar and wind power, and improves grid integration via smart grids and energy storage solutions. It supports sustainable practices through biomass and waste-to-energy technologies and drives innovation with R&D in emerging fields like hydrogen energy. Technology also aids policy-making with data-driven insights and attracts investment, creating jobs and fostering economic growth. Ultimately, it enhances resilience of energy infrastructure to climate impacts.

In Vietnam, the concept of green technology is not specifically defined in any legal text. However, related concepts such as “environmental industry” are addressed in the Law No. 55/2014/QH13 on Environmental Protection. However, when the law became invalid, the new legislation did not include such provisions. The Law No. 07/2017/QH14 on Technology Transfer can be seen as a document encompassing various related concepts to green technology, such as advanced technology, new technology, clean technology, and high technology[*]. The commonality among these concepts is that they refer to technologies, either in process or product form, that minimize negative environmental impacts within one or across the entire technological process.

The findings of Chris Vale, Duong Vu demonstrate that the sectors leading in the green energy in Vietnam are agriculture/forestry, alternative energy production, and waste management. Conversely, sectors such as energy conservation and administrative show a notably lower volume of patent applications, while the nuclear power generation sector accounted for a mere 1%. Notwithstanding their continued contribution to the overall growth of green energy technologies, patent filings in areas such as agriculture/forestry and waste management have experienced a decline in recent years (Chris & Duong, 2021).

4.2. Patent from a legal perspective and its impact on the development of green technologies

According to the WIPO, an invention is simply defined as “a new product or process aimed at solving a technical problem”, while a patent is “a document granted by a country based on a protection request, which describes an invention and establishes a legal condition under which the patented invention can only be commercially exploited (manufactured, used, sold, imported) with the permission of the patent holder” (WIPO, 2007). The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of 1994 does not provide a definition for patent. Instead, TRIPS sets out standards for patent protection as outlined in Article 27(1): “Patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application”. One of the main benefits of the patent system for the patent holder is the legal protection it offers for their inventions. When an entity is granted a patent, it means that the holder has exclusive rights to their invention, preventing others from copying, using, or selling the invention without their permission.

Research has demonstrated a close relationship between the development of green technologies and patents. The number of green patents is one of the key indicators of green innovation and has a positive impact on promoting green technologies in the long term (Serkan & Mine, 2021).

The relationship between patent and green technology is integral to promoting innovation and addressing environmental challenges. Patents provide inventors with exclusive rights to their innovations, which incentivizes the development of new technologies, including those aimed at environmental sustainability. This legal protection encourages investment in research and development, fostering technological advancements in areas like renewable energy, energy efficiency, and pollution control. Patents motivate companies and inventors to invest in green technologies by ensuring they can recoup their investment through exclusive rights. This protection fosters innovation in areas such as clean energy, waste management, and resource conservation. Beside, patents play a vital role in bringing green technologies to market. By protecting intellectual property, they make it easier for innovators to secure funding and partnerships, which are essential for large-scale deployment of eco-friendly technologies.

While patents grant exclusivity, they also require disclosure of the technology to the public. This promotes the dissemination of technical knowledge, allowing other innovators to build upon existing inventions and accelerate technological progress. Moreover, an effective patent system plays a critical role in facilitating technology transfer, thereby promoting economic and technological development. Contemporary evidence highlights the vast disparity in technology access between less developed, developing, and developed nations (UNCTAD, 2007). Consequently, a robust and predictable intellectual property framework is essential for supporting technology transfer agreements, fostering the exchange of expertise, and narrowing the development gap. Therefore, strong legal protections and the reinforcement of industrial property rights concerning patents are fundamental to driving innovation and ensuring sustainable development.

As a developing nation, Vietnam views green technologies and the protection of green patents as integral components of its strategy for sustainable development. The country faces significant environmental challenges, including the adverse effects of climate change and pollution, compounded by the depletion of natural resources over recent years. According to data from the OECD and the World Bank, a substantial proportion of Vietnam’s population is exposed to dangerous levels of pollution, often surpassing the thresholds outlined by the World Health Organization. Nearly the entire population experiences high levels of pollution exposure, and Vietnam ranks 27th globally in greenhouse gas emissions, contributing 0.72% of global emissions (T.D.Hoanh, 2017). These statistics underscore the urgent environmental challenges Vietnam confronts as it strives to meet the SDGs. Given these pressing concerns, it is imperative that policymakers prioritize the development of green technologies and strengthen the legal mechanisms for the protection of green patents. Doing so will not only encourage innovation but also foster sustainable growth and environmental resilience in the long term.

4.3. The current state of patent policies for green technologies in Vietnam

Between 2011 and 2018, Vietnam witnessed a significant increase in the number of green patent applications and grants, with the country emerging as one of the top global leaders in green patents, accounting for 30.3% of the total worldwide (Chris & Duong, 2021). Despite this progress, Vietnam’s position in the 2019 International Property Rights Index was relatively low, ranking 89th out of 129 countries and 6th out of 7 ASEAN countries assessed that year (WIPO, 2020, B). This discrepancy can largely be attributed to the current shortcomings in Vietnam’s green patent protection policies.

Firstly, Vietnam's policies for green patent protection are significantly shaped by its international intellectual property commitments. As a signatory to various international agreements, Vietnam's approach to green patents is guided by global standards and obligations, which impact the development and enforcement of its domestic regulatory framework. Vietnam, as a member of the World Trade Organization (WTO) since 2007, is obligated to comply with the TRIPS. The "one-size-fits-all" approach refers to the uniform application of TRIPS standards to all WTO member states, regardless of their varying levels of economic development, technological advancement, and institutional capacities, create barriers to accessing and adopting green technologies, particularly in developing countries like Vietnam (Christophe & Luc D, 2021). While TRIPS aims to incentivize innovation through intellectual property protection, its uniform standards may not effectively promote greentech innovation in Vietnam, where the innovation ecosystem is still developing. Additionally, TRIPS'strict intellectual property rules may limit Vietnam's ability to implement policies that support green technology and sustainable development, presenting a challenge in balancing intellectual property protection with public interest objectives like environmental sustainability.

The stringent regulations under TRIPS have raised concerns among developing countries, including Vietnam, about their ability to access and adopt green technologies. The latest report from the UNFCCC, Ad-hoc Working Group on Long-Term Cooperative Action has put forward specific intellectual property-related proposals for the post - Kyoto climate framework. These proposals, primarily advanced by developing countries, include several regulatory measures: the establishment of patent pools, the implementation of compulsory licensing for green technologies without royalties, the exclusion of certain green technologies from patent protection, and the potential revocation of existing patent rights on such technologies. These measures are intended to enhance the accessibility of crucial technologies necessary for climate change mitigation, particularly for nations that may face barriers under the current intellectual property framework.

Secondly, the legal framework for patent protection in Vietnam is deficient in that it does not provide specific definitions for greentech and green patent within key legislative instruments, such as the Law No. 50/2005/QH11 on Intellectual Property Law and the Law No. 07/2017/QH14 on Technology Transfer Law. This lack of explicit definitions poses significant challenges in the application of intellectual property regulations, including the establishment of criteria for patenting green technologies and resolving intellectual property disputes related to these technologies. Furthermore, the absence of clear definitions complicates the efforts of government agencies to develop and implement policies that support greentech, such as tax incentives, financial support, and promotional measures for technological advancement, as outlined in the Law on Technology Transfer.

The lack of specific definitions for "greentech" and "green patent" in Vietnamese legislation has led to a significant gap in the criteria for classifying such patents. At present, Vietnam relies exclusively on the IPC system, developed by the WIPO, for the classification of patents. The IPC system organizes patents based on technical and technological fields and serves as a fundamental tool for the organization and management of patent information. However, the IPC does not provide specific definitions or classifications for green technologies and green patents, which creates ambiguity in the assessment and granting of patents for inventions with environmental benefits.

Green patents frequently involve a combination of various technologies, complicating their classification under the IPC and potentially leading to inaccuracies. The lack of a specific classification framework for greentech hampers the effective evaluation and protection of environmentally beneficial innovations. Moreover, Vietnam has not adopted the Green IPC classification system, a supplementary framework developed by WIPO to facilitate the categorization of patents related to greentech and environmental protection. Although not mandatory, the Green IPC system provides a more targeted approach to classifying patents with positive environmental impacts, which could enhance the precision of patent assessments and support the development of green technologies.

Thirdly, the commercialization of green patents in Vietnam is impeded by a lack of specific legal provisions. Currently, Vietnamese law does not provide a precise definition for "commercialization of green patents". The existing legal framework includes the concept of "commercial activities" under the Law No.36/2005/QH11 on Commerce and "commercialization of research results" in the Law No. 07/2017/QH14 on Technology Transfer. However, these laws do not offer detailed guidelines on the processes or methods for the exploitation of green patents, nor do they outline the roles of intermediary organizations that could facilitate this process. The absence of such detailed regulations complicates efforts for innovative startups, especially those in green technology, to substantiate their legal claims and safeguard their rights and interests.

Regarding the valuation of green patents, Vietnamese law lacks specific provisions for assessing intangible assets, including green patents. There is no officially designated organization responsible for conducting patent valuations, nor are there established procedures for such valuations. Given the high variability and the specialized expertise required for assessing green patents, the absence of regulatory guidance may lead to inconsistent and ad hoc valuations. This inconsistency can adversely impact the commercial interests of stakeholders engaged in transactions involving green patents.

Furthermore, the use of green patents as capital contributions faces challenges due to the lack of clear regulations on valuation. Additionally, Article 34 of the Law No. 59/2020/QH14 on Enterprises stipulates that contributors must be the legal owners of the patents. This provision creates difficulties for patent holders who possess patents granted abroad (where intellectual property rights are territorial and patents are valid only within the jurisdiction of the issuing country) or for those whose patent applications are still under examination. These regulatory gaps hinder many companies in the green technology sector from effectively leveraging the commercial value of their green patents.

Fourthly, the regulatory framework for transferring industrial property rights related to green patents is crucial for maximizing their commercial potential. Under Vietnam's intellectual property law, the transfer of patent rights includes (i) the transfer of ownership and (ii) the transfer of usage rights. Both processes require formal written contracts and registration with the Intellectual Property Office of Viet Nam (Articles 138, 141, 148 Law No. 50/2005/QH11 on Intellectual Property Law).

However, practical challenges arise due to overlapping legal requirements. Technology transfer agreements, often involving green patents, must comply with both the Law on Intellectual Property Law and the Law on Technology Transfer Law. These agreements require detailed documentation and additional registration if they involve foreign parties. The complexity of these requirements and the need for multiple regulatory steps can hinder the efficient transfer and commercialization of green patents.

Fifthly, the lack of a dedicated registration process for green patents complicates their protection. The current patent registration process in Vietnam is protracted, often requiring a minimum of two years, excluding any time for appeals (VNIPO, 2024, A). This extended duration negatively impacts the commercialization of green patents.

Internationally, because patent rights are territorial, protection is confined to the jurisdiction of the issuing country, increasing the risk of unauthorized exploitation of green patents in countries where they are not registered. To mitigate these challenges, many countries are parties to the Patent Cooperation Treaty (PCT). Under the PCT framework, applicants from member states can file a single international patent application, which is then forwarded to all PCT member countries (WIPO, 2020a). Despite this, the PCT does not address the issue of protracted examination periods, as the timeframes for substantive and formal examination are still subject to the regulations of the respective national patent offices.

4.4. Recommendations for patent policy for green technologies in Vietnam

Firstly, to address the limitations of the "one-size-fits-all" approach of TRIPS, Vietnam should leverage the flexibility inherent in the implementation of TRIPS standards. Specifically, advocating for greater flexibility can enable Vietnam to better align its intellectual property policies with national developmental goals and environmental needs. This approach may involve negotiating for specific exemptions or adjustments in critical areas, particularly those impacting national development and environmental protection.

Vietnam can utilize provisions within the TRIPS Agreement such as Public policy objectives (Article 8) and Exceptions to patent rights (Article 30) to align intellectual property regulations with public interests. Article 8 permits members to adopt measures necessary to protect public health, the environment, and sustainable development, even if these measures deviate from standard TRIPS obligations. Similarly, Article 30 allows for exceptions to patent rights in certain cases, provided these exceptions do not unreasonably conflict with the normal exploitation of the patent. By applying these provisions, Vietnam can implement intellectual property measures that effectively balance the need for innovation with its public policy objectives, including environmental sustainability and health protection.

Secondly, Vietnam should formally define "green technology" and "green patents" within the context of its Intellectual Property Law and Technology Transfer Law. Establishing precise definitions and classifications for green technologies that qualify for patent protection is crucial for streamlining the patent application process and fostering the development of green technology. Additionally, Vietnam should consider the implementation of a Green IPC system. Adopting the Green IPC could enhance the current classification framework by providing more specific definitions and categories for green technologies, thereby improving the accuracy and efficiency of patent examination and search processes. The integration of Green IPC can be harmonized with the existing IPC system by introducing supplementary classification categories that align with Vietnam's greentech objectives and developmental needs, thus facilitating more effective protection and promotion of green innovations

Thirdly, to promote the commercial exploitation of green patents, it is essential to establish more detailed and specific regulations regarding the transfer of intellectual property rights related to green patents and the valuation of such patents. This will help mitigate legal risks and create favorable conditions for innovative startups in the green technology sector. Specifically, it is necessary to clarify and refine the provisions in Article 34 of the Law No. 59/2020/QH14 on Enterprises concerning what constitutes "legal ownership" or "legal usage rights" of intellectual property assets, with a focus on green patents. The regulations should allow entities to contribute green patents, which have been granted protection in foreign jurisdictions, as capital. Additionally, it should be stipulated that holders of exclusive usage rights for green patents are permitted to use these rights for capital contribution, provided that the usage rights are exclusive. This will help minimize disputes and safeguard the value of the contributed assets. Furthermore, regulations should be established to address the contribution of green patents that are currently under examination. This will ensure transparency and legal security for all parties involved in the investment and capital contribution process. These measures will enhance the legal framework, facilitate the commercialization of green patents, and encourage the development of green technology sector.

Fourthly, it is essential to streamline the registration process for industrial property transfer agreements and patent licensing agreements related to green technologies, particularly regarding their effect on third parties. Specifically, it is recommended that, for technology transfer agreements involving green patents between Vietnam and foreign entities (or vice versa), the registration procedure should be centralized at the Intellectual Property Office of Viet Nam. This proposal aims to replace the current complex administrative process, thereby minimizing the need for compliance with multiple bureaucratic procedures across various agencies. Simplifying this process would enhance incentives for inventors, stimulate research and development in green technology, and improve the legal framework to facilitate technology transfer. Such reforms would not only assist innovative startups in exploiting green patents but also alleviate administrative burdens, attract investment, and promote green technology transfer. This, in turn, would support sustainable development and help Vietnam meet its greenhouse gas emission reduction commitments under international agreements.

Fifthly, to enhance the commercialization and examination of green patents, and to capitalize on the benefits of patent disclosure, it is crucial to advance cooperation at the bilateral, multilateral, and international levels.

i) Bilateral cooperation: Vietnam has entered into pilot agreements for the Patent Prosecution Highway (PPH) program with Japan (since 2018) and South Korea (since 2019) (Iphouse & Associates, 2021). These agreements, which have been extended twice, currently impose a cap of 100 requests per year from each participating office. However, the volume of patent and utility model applications filed with the Vietnam Intellectual Property Office from Japan and South Korea exceeds 1,000 applications per country annually (e.g., 1,635 from Japan and 1,236 from South Korea in 2021) (VNIPO, 2024, B). Additionally, major patent offices from China, the United States, and the European Union also have substantial application volumes in Vietnam but are not covered under PPH agreements. Therefore, it is imperative to strengthen bilateral cooperation with these jurisdictions to facilitate more efficient patent examination processes.

ii) Multilateral cooperation: At the multilateral level, Vietnam participates in the ASEAN Patent Examination Cooperation (ASPEC) program, which is the first regional initiative for patent examination within ASEAN (VNIPO, 2019). Launched in 2009, the ASPEC program enables intellectual property offices in ASEAN member states to leverage results from searches and examinations conducted by other participating offices.

iii) International cooperation: To enhance the examination and commercialization of green patents, Vietnam should actively engage with the WIPO Green Strategy, which commenced in 2019 (WIPO, 2023). This strategy involves the development of an online platform for the exchange of green technologies, drawing on WIPO's Patentscope database, which contains over 70 million patents. This platform aims to expedite the adaptation, implementation, and dissemination of green technologies, facilitate access to innovative solutions for countries at varying levels of development, and support SDGs related to climate change, food security, and environmental protection. For a developing country like Vietnam, this represents a valuable opportunity to efficiently access and integrate open and green technologies.

5. Conclusion

Vietnam's journey towards achieving net-zero emissions and fostering sustainable development is closely intertwined with the advancement of green technology and the effective management of green patents. To support this ambitious goal, it is crucial to establish a robust legal framework that facilitates the growth and commercialization of green technologies while protecting intellectual property rights.

Vietnam must enhance its legal and regulatory environment to support the development and deployment of green technologies. This includes refining patent laws and regulations to streamline the examination and approval processes for green patents, such as: implementing specialized green patent procedures, clarifying patent valuation and transfer regulations, establishing clear guidelines for the valuation, transfer, and licensing of green patents will reduce legal uncertainty and encourage investment and collaboration in green technology sectors, strengthening international cooperation and facilitating green technology integration.

By strengthening its legal framework and supporting green technologies and patent management, Vietnam will not only advance its net-zero emissions targets but also establish itself as a leader in sustainable innovation. This comprehensive approach will drive progress towards environmental sustainability, boost economic growth, and contribute to global efforts against climate change.

<u>Notes</u>* Law No. 07/2017/QH14 on Technology Transfer, Article 02:

"*3. Advanced technology refers to the technology which has a technological level higher than the current technological level of the same type in Vietnam and has been applied to the reality to improve the productivity and quality of products, and produce high-quality and eco-friendly products.*

4. New technology refers to the technology which is developed or applied in Vietnam or in the world for the first time with the technological level higher than the current technological level of the same type in Vietnam, eco–friendly, applied to the reality and capable of improving the productivity and quality of products.

5. Clean technology refers to the technology that generates less environmental pollutants as defined in the law on technical standards and regulations, and uses less non-renewable resources than existing technology.

6. High technology means the technology with a high content of scientific research and technological development; which is integrated from modern scientific and technological achievements; creates high-quality and eco-friendly products with high added value and significant features; plays key role in forming new manufacturing or service industry or modernizing an existing manufacturing or service industry."

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Bioclimatic Factors in Architectural Heritage during 1973-1986 in Hanoi

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Abstract

Bioclimatic is an architectural design approach trend that is being promoted in the context of global climate change. It takes into account local climate and environmental conditions to create buildings that are energy efficient and provide optimal thermal comfort for humans using passive strategies. The architectural works of the period 1972-1986 in Hanoi were built during a period when air conditioning was not commonly used. Architects had to design to adapt to the hot and humid climate in the Northern region of Vietnam. They have created cool spaces without the use of air conditioning. Unfortunately, after being renovated, some buildings remove these advantages and use air conditioning instead. The paper will explore the change in cooling technology of buildings during the renovation process, from the original passive cooling to the use of air conditioning. This leads to a change in the form and the shape of the building, losing the original state of the heritage. The paper will present the results of in-depth interviews with two subjects: architects and users, with the case study being the Ministry of Education Headquarters. Through this, readers will be aware of the arguments of each side in the renovation of the building and the meaning of the bioclimatic factor is different depending on the interview subject.

Keywords: *Bioclimatic architecture, architectural heritage, architecture in period 1973-1986 in Hanoi*

1. Introduction

The nature of architecture always creates the best comfort and convenience for users. Bioclimatic architecture is a design method that considers local climatic conditions to create buildings that ensure thermal comfort, light, humidity, and more. Elements of bioclimatic design include building orientation, insulation, ventilation systems, plants as well as heat storage to reduce energy consumption and environmental impact (Goulding, Owen Lewis, 1997). This is not new, because it is fair to say that all traditional architecture is, by nature, bioclimatic (Manzano-Agugliaro et al, 2016). Traditional architecture in Northern Vietnam went through a long development process, in which the community created knowledge to adapt the building to the typical climate: hot and humid subtropical. Parts of traditional architecture, such as veranda, open corridors, courtyard, and curtains, help reduce direct solar radiation into the interior and naturally condition air (Pham DN, 2002). These traditional experiences are quite similar to today's bioclimatic building design. Broadly speaking, all traditional architecture has within itself the principles of green architecture (Goulding, Owen Lewis, 1997:6-7).

Absorbing traditional experiences, combined with modern science, bioclimatic building design continues to be implemented for architectural works in the period 1973-1986 in Hanoi. During this period, air conditioners were very rare in Hanoi, so architects had to carefully research and calculate the heat factor so that the building could withstand the disadvantages of the hot and humid climate. The solution is still open corridors, courtyards, brise-soleil, but is scientifically calculated to save maximum costs in the country's poor economic conditions. Nowadays, the architectural works of the period 1973-1986 in Hanoi have become a heritage, preserving social memories of a difficult but brave period in Hanoi, a clear testament to the title “City for Peace”. It is a pity that nowadays most of these works have been renovated and are no longer original. During the renovation process, some heritage values have changed, including bio-climatic architectural solutions.

1.1. Characteristics of architecture in the period 1973-1986 in Hanoi

After The Paris Peace Accords (1973), Hanoi began to build important projects, representing a new phase of the city, leaving behind the image of ruins caused by American bombs. Typical projects include: Ho Chi Minh Mausoleum, Post Office Hanoi, Hanoi Children's Palace, Government Guest House, Thang Loi Hotel, Labour Culture Palace, Ministry of Education Headquarters, etc.

Figure 1: Post Office Hanoi (1975)

Source: Author

Figure 2: Ha Noi Children Park (1976)

Source: Author

Characteristics of architecture in the period 1973-1986 were influenced by:

Policy and ideology: After unifying the country, nationalism continued to be proposed as a way to reduce social differences between the North and South in the post-war period. "Socialism and nationalism" were the basic cultural development path in the previous period, and continued to be emphasized in the Documents of the Fourth Congress of the Communist Party of Vietnam (1976) and the Fifth (1982). In that spirit, architecture in the 1975-1986 period was developed in a socialist direction with a modern and national character (Dang HV, 2016). Socialist direction means being in harmony with Socialist modernism in Eastern Europe and the Soviet Union. Nationalist architecture in this period is specifically expressed in bioclimatic solutions, that traditional architecture has had thousands of years of experience with (Tran HT, 1976).

Economy: The centralized bureaucratic and subsidized economic management, wars with China and the Khmer Rouge, embargoes, and reduction of foreign aid led to a decline in construction investment. Projects are built with the criteria of “beautiful in possible conditions”; construction equipment is invested at a minimum level (Nguyen DV, 2023). Most of the large-scale works and impressive architectural forms during this period were aided from abroad.

Diplomacy: Supporting the reconstruction of Hanoi after the war, Socialist countries and some left-wing governments provided aid to build new projects such as: Post Office Hanoi (Chinese aid , designed by Vietnamese architects), Children's Palace (aided by Czechoslovakia, designed by Vietnamese architects), Thang Loi Hotel (aided and designed by Cuba), Labour Cultural Palace (aided and design by USSR), Central Children's Hospital (aided and design by Sweden), French Faculty – VNU (aided and design by France), etc. These projects are designed and built with high quality, modern style, coherent lines, and suitable for Vietnam's climate.

Civil engineering: Thanks to absorbing advances in concrete techniques, construction projects at this stage have relatively fully expressed modern architectural language, with free layouts, abstract composition. The project is built on a column system, freeing up space on the first floor, using brise-soleil to adapt to the hot and humid climate. The project's functions and technical systems are carefully researched to save construction costs but achieve high efficiency (Le VL et al, 2010).

Architects: This period is the opening stage for a new generation of architects, trained in a socialist educational environment at home and abroad (Eastern Europe, the Soviet Union, China, Cuba). Escaping from the shadow of architects trained at the Indochina College of Fine Arts during the French colonial period, the younger generation of architects have firmly mastered design work, based on the principles of Socialist modernism.

In 1986, Vietnam began implementing Đổi Mới (Innovation). The Socialist modernism of the period 1973-1986 was replaced by new architectural styles, in harmony with contemporary architectural trends of the world, demonstrating Vietnam's multilateral diplomatic strategy.

1.2. Research problem

The architectural heritage during 1973-1986 in Hanoi has maintained traditional experience in bioclimatic architecture, and has become valuable lessons for young architects in the current era of green transformation. Solutions such as open corridors, courtyards, brise-soleil, which were typical of the architecture of that period, are rarely used today. The reason is that the air-conditioning cooling system, which is widespread today, does not require such architectural elements.

Because of difficult economic conditions, projects built in the period 1973-1986 have degraded quite quickly. Most of the buildings have been renovated and reused. One of the problems with renovation is the loss of the environmental and scientific-educational value of the heritage. Originally, these projects used traditional experiences in bioclimatic building design and passive cooling techniques with open corridors, courtyards, and brise-soleils. After renovation, these details and techniques are not noticed. The layout and elevation are both changed from the original. Instead, in most projects, people use ductless mini-split system air conditioner. The result is the creation of outdoor units on the facade, causing the aesthetics of the building to decline. The question is, is the bioclimatic factor really a value that must be protected in the architectural heritage of the period 1973-1986 in Hanoi?

2. Methods

This paper is based on a systematic review of the academic literature on the intersection between bioclimatic architecture and heritage values. The review process included searching relevant databases, screening articles based on predetermined inclusion criteria, and synthesizing key findings across multiple studies. In addition, we conducted field surveys to record changes in the buildings after renovation, especially bioclimatic architectural elements.

To collect and process data, the article mainly uses qualitative methods, especially in-depth interviews. In-depth interviews have the following advantages: flexible structure, high interactivity, and the opportunity to discover core issues from the interviewee's deep thoughts. Interview subjects include: people using the building, architects designing heritage buildings, and heritage experts. In addition, the article also uses quantitative methods to survey the current status of renovating architectural heritage in terms of bioclimatic building design.

3. Results

3.1. Field survey result: A decline in passive cooling techniques after renovation

The process of surveying the current status of renovation of architectural heritage in the period 1973-1986 in Hanoi showed that there were changes in air conditioning techniques, passive techniques were replaced by electrical. During the period 1973-1986 in Hanoi, electrical air conditioning techniques were not commonly applied, except for some very special projects. To limit the negative effects of hot and humid climate on the building, architects have used a number of techniques: brise-soleil on the facade, double-wall construction, orientation of building (to limit sunlight exposure), open corridor, inner courtyard (for better air circulation). After 1990, international air conditioning brands gradually entered the Vietnamese market and were warmly welcomed. Passive techniques are used less and less, both in new designs and renovations of old buildings, replaced by electrical techniques.

Table 1 shows that 90% of the projects after renovation added electrical techniques, specifically split-type air conditioner; 60% of projects still retain passive techniques in form but actually use electrical techniques; 10% keep both form and content of passive techniques unchanged; 20% of projects have changed both form and content of passive techniques, switching to using only electrical techniques.

Table 1: Survey of changes in air conditioning techniques after renovation of architectural heritage sites in the period 1973-1986 in Hanoi (10 typical projects)

	Building	Year	Before renovation	After renovation
1	Post Office Hanoi	1975	PCT	EACT
2	Central Children's Hospital	1975	PCT	PCT, EACT
3	Government guesthouse	1976	PCT	PCT, EACT
4	Thang Loi Hotel	1976	PCT	EACT
5	Ha Noi Children Palace	1976	PCT	PCT, EACT
6	Maternity hospital	1979	PCT	PCT , EACT
7	Labor Cultural Palace	1980	PCT, EACT	PCT, EACT
8	Faculty of French - VNU	1984	PCT	PCT
9	Headquarters of the Ministry of Education	1986	PCT	EACT
10	Institute of Rare Radiation Technology	1986	PCT	PCT, EACT

(PCT: Passive Cooling Techniques; EACT: Electrical Air Conditioning Techniques)

Source: Author

Figure 3: Adding ductless mini-split system air conditioner to offices at the Ministry of Education Headquarters

Source: Author

3.2. In-depth interview results: Different perspectives for the conservation of bioclimatic elements in architectural heritage

Case study: Ministry of Education Headquarters

(Results from in-depth interviews with architect Tran Thanh Binh, who designed the Ministry of Education Headquarters, and a number of staff working at the Ministry).

3.2.1. Architect's perspective

The Headquarters of the Ministry of Education was inaugurated in 1986 according to the design of architect Tran Thanh Binh. In 1978, Mr. Binh, who recently returned to the country after graduating from the Kyiv University of Architecture and interning at the University Design Institute in Moscow, won the competition to design the Ministry of Education Headquarters). Mr. Binh’s proposal (Fig.4) convinced the jury with three strong points: first, the dignified and strong form of the Socialist modernism; second, strict and scientific functionality to achieve the best operating efficiency in tight economic conditions; third, architectural details not only demonstrate formal beauty but more importantly solve the bioclimatic problem, based on traditional experience and careful calculations according to modern architectural physics.

From 2000 to present, the Ministry of Education Headquarters has been renovated many times. All three original advantages of the project are reduced or disappeared. First, the shape and proportion of the building have been transformed, into an architectural style of unknown style and without identity (Fig.5). Second, the function is changed due to the minister's preferences and the need to increase the usable area. Finally, details representing bioclimatic architecture were not preserved.

For the Ministry of Education Headquarters, architect Tran Thanh Binh is very proud to have convinced the jury of the aesthetic value of bioclimatic architecture. The project uses brise-soleil on the façade with a strong composition, harmonious proportions and rich textures (concrete, pebble wash, ventilation tiles, bricks, glass). In the centre of the headquarters is a courtyard with trees and water tanks to ensure a good microclimate. The architect also created semi-open spaces located at the transition between blocks to provide natural ventilation and natural lighting for the interior corridors.

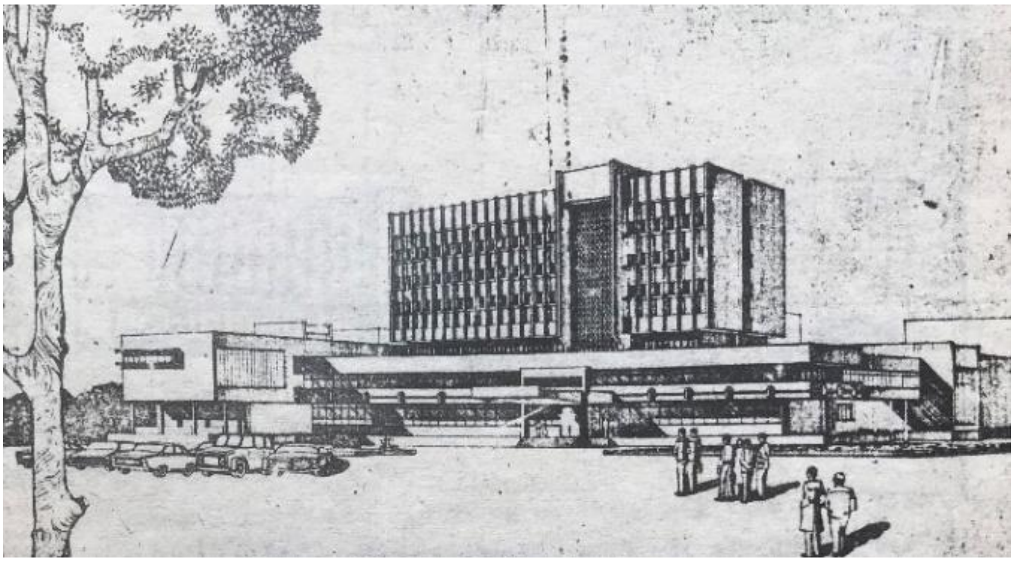

Figure 4: Ministry of Education Headquarters by architect Tran Thanh Binh in 1978

Source: Tran, 2978

Figure 5: Ministry of Education Headquarters after renovations (2024)

Source: Author

3.2.2. User's perspective

The author of the paper interviewed a number of staff who worked for many years at the Ministry of Education Headquarters. The results show that:

Firstly, users do not care much about aesthetic factors; the project may look worse in the eyes of experts but for them it is not a big problem.

Second, electrical air conditioning techniques provide more comfort, especially during the peak summer months. Even though we know that electrical air conditioning techniques cause many negative consequences for the environment, the whole city of Hanoi uses them, so why should they refuse?

Third, Ministry staff use personal cars more, leading to a lack of parking spaces, so demolishing gardens to create parking lots is also reasonable. When it was suggested that they could build a basement for parking with green trees above, they admitted that it was better option.

4. Discussion and Conclusion

Thus, there is a difference in perception between the designer and the user in the case that the Ministry of Education Headquarters after the project is renovated is different from the original image. While architects regret the decline in aesthetic, environmental, scientific and educational values of heritage, users care about their own comfort and convenience.

To harmonize the interests of all parties in the process of renovating architectural heritage in the period 1973-1986 in Hanoi, the author of the article makes some proposals as follows:

Firstly, propagate to the public to be aware of the value of architectural heritage in the period 1973-1986 in Hanoi. If these heritage sites are not preserved, Hanoi city is at risk of losing its memory of a historical period. Secondly, the user's needs regarding electrical air conditioning need to be taken into account. However, a renovation plan must be proposed so as not to eliminate passive cooling solutions such as planted courtyards, semi-open spaces, ventilation corridors, brise-soleils. Besides, it is necessary to choose appropriate technology to avoid ugly outdoor units appearing on the facade. Thirdly, emphasize the bioclimatic factor in the architectural heritage of the period 1973-1986, considering it as a core value that needs to be preserved, at least in terms of form.

In the current era of green transition, bioclimatic factors are not only important for the design of new buildings but also the value of architectural heritage that must be preserved. Through this preservation, younger generations will realize that green architecture is not just a temporary contemporary trend but is actually the essence of architecture, from the past to the present and the future.

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SECTION V

ENVIRONMENTAL SUSTAINABILITY

The Impact of Environmental Knowledge and Green Advertising on Green Purchase Intention through Environmental Attitude

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Abstract

This study investigates the impact of environmental knowledge and green advertising on green purchase intention through environmental attitudes among consumers in Ho Chi Minh City, Vietnam. The research utilizes a convenience sampling method to survey 250 customers at major shopping malls, with 241 valid responses collected for analysis. The study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the proposed hypotheses. Findings indicate that environmental attitude significantly influences green purchase intention, while environmental knowledge positively affects environmental attitude but does not directly impact green purchase intention. Similarly, green advertising enhances environmental attitudes but does not directly affect green purchase intention. These results suggest that while raising awareness through green advertising and enhancing environmental knowledge can foster positive attitudes toward environmental conservation, additional factors such as perceived product quality and trust in green claims are necessary to translate these attitudes into actual purchase intentions. The study highlights the importance of integrating comprehensive environmental education and authentic green marketing strategies to promote sustainable consumption behaviors among consumers effectively.

Keywords: *Environmental attitude, environmental knowledge, green advertising, green purchase intention*

1. Introduction

Environmental sustainability has become a pressing concern globally, influencing both consumer behavior and corporate strategies (Paul et al., 2016). In Vietnam, rapid economic development and urbanization have led to significant environmental challenges, such as pollution, resource depletion, and waste management issues (Hoang et al., 2013). As awareness of these problems increases, Vietnamese consumers are becoming more environmentally conscious, creating a growing demand for eco-friendly products and services (Nguyen et al., 2021). This shift presents an opportunity for businesses to align their marketing strategies with sustainable practices, contributing to a greener economy. Despite this emerging trend, there needs to be more literature regarding the specific factors that drive green purchase intentions in Vietnam, a rapidly developing economy with unique socio-economic and cultural dynamics.

Most existing research on green consumer behavior has focused on developing countries, where environmental awareness and cultural attitudes toward sustainability differ significantly from those in Vietnam (Ahmed et al., 2020; Balaskas et al., 2023). Consequently, there needs to be more understanding of how Vietnamese consumers translate their environmental knowledge into actual purchasing behaviors and how effective green advertising is in this context (Zaremohzzabieh et al., 2021). Moreover, while environmental attitudes are known to influence green purchase intentions, the mediating role of these attitudes in the relationship between environmental knowledge, green advertising, and green purchase intentions has yet to be thoroughly investigated in Vietnam (Nguyen et al., 2021). Given the country's unique environmental challenges and its strategic importance as a developing market in Southeast Asia, understanding these dynamics is crucial.

This study addresses these gaps by exploring the impact of environmental knowledge and green advertising on green purchase intentions through environmental attitudes among consumers in Ho Chi Minh City, Vietnam. This study provides a contextual understanding of green consumer behavior in a developing economy. The findings are expected to offer practical implications for businesses and policymakers, highlighting the importance of fostering environmental solid attitudes and implementing effective green marketing strategies to promote sustainable consumption. This study not only contributes to the theoretical development of consumer behavior models in the context of sustainability but also supports the broader goal of achieving a sustainable economy in Vietnam.

2. Literature review

2.1. Green purchase intention

Intention, in the context of consumer behavior, refers to an individual's conscious plan or decision to engage in a specific behavior. It represents a person's motivational factors that influence their behavior, showing how much effort they are willing to exert to perform that behavior. According to the Theory of Planned Behavior, intention is a crucial predictor of actual behavior, influenced by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). Green Purchase Intention refers explicitly to a consumer's intention to buy environmentally friendly products. It reflects the likelihood or willingness of consumers to choose products that are perceived to be less harmful to the environment. Green purchase intention is shaped by various factors such as environmental attitudes, awareness, perceived value, and social influence, and it serves as a critical antecedent to actual green purchasing behavior (Chen & Chang, 2012; Paul et al., 2016).

2.2. Environmental attitude

Environmental attitude refers to an individual's set of beliefs, feelings, and behavioral intentions regarding the environment and its conservation. It reflects a person's level of concern for environmental issues and their commitment to actions that protect the environment (Milfont & Duckitt, 2010). A positive environmental attitude often predicts pro-environmental behaviors, such as recycling and supporting green initiatives. When individuals hold positive attitudes towards environmental conservation, they are more inclined to act consistently with these beliefs in their purchasing decisions. Studies have shown that a solid environmental attitude enhances the likelihood of choosing green products over conventional ones, as consumers view green purchases as a way to express their environmental values (Carrión-Bósquez et al., 2024). Research also indicates that individuals with a positive environmental attitude are more receptive to environmental information, further reinforcing their intention to buy sustainably (Indriani et al., 2019).

H1: Environmental attitude has a positive and significant effect on green purchase intention.

2.3. Environmental knowledge

Environmental knowledge refers to an individual's understanding and awareness of environmental issues, such as the causes and effects of pollution, climate change, and resource conservation. It encompasses factual information and practical knowledge of how personal and collective actions impact the environment (Frick et al., 2004). Higher environmental knowledge is often associated with increased pro-environmental behavior, as it helps individuals make informed decisions regarding sustainable practices. Individuals with higher environmental knowledge are more likely to develop positive attitudes toward environmental protection as they understand the causes and consequences of environmental degradation and the need for sustainable practices. Increased environmental knowledge fosters concern for environmental issues, leading to more favorable attitudes toward conservation (Liu et al., 2020). It provides a framework for comprehending environmental challenges and supporting sustainability efforts. Research indicates that informed individuals are more likely to engage in pro-environmental behaviors, such as recycling and energy conservation (Erhabor et al., 2016). Moreover, knowledge about environmental impacts influences consumer choices, encouraging them to opt for products that align with their values and support sustainable practices (Noor et al., 2012). This understanding helps consumers distinguish between genuinely eco-friendly products and those that are not, leading to more informed decisions and a stronger intention to buy green products (Ahmed et al., 2020).

H2: Environmental knowledge has a positive and significant effect on environmental attitude.

H3: Environmental knowledge has a positive and significant effect on green purchase intention.

2.4. Green advertising

Green advertising involves marketing efforts that emphasize the environmental benefits of products or services, aiming to raise awareness and persuade consumers about the advantages of sustainable choices. It highlights practices like reduced carbon footprints, sustainable sourcing, and recycling to influence consumer attitudes and promote eco-friendly behaviors. When consumers are exposed to Green advertising, they become more aware of environmental issues and the actions companies take to mitigate them. This increased awareness can lead to more positive attitudes towards environmental conservation and sustainable practices. Recent studies have demonstrated that Green advertising effectively shapes consumers' attitudes by highlighting the environmental impact of their consumption choices (Kaur et al., 2021). By framing products and services as environmentally friendly, green advertising can foster a sense of environmental stewardship among consumers, encouraging them to adopt pro-environmental attitudes.

Moreover, green advertising can strengthen environmental attitudes by appealing to consumers' values and beliefs about environmental protection. When advertisements emphasize the importance of sustainability and the role individuals play in achieving it, they can create a stronger emotional connection between consumers and environmental causes. This connection often leads to a positive shift in attitudes, as consumers are more likely to align their beliefs with the environmental values promoted in the advertising (Balaskas et al., 2023).

H4: Green advertising has a positive and significant effect on environmental attitude.

H5: Green advertising has a positive and significant effect on green purchase intention.

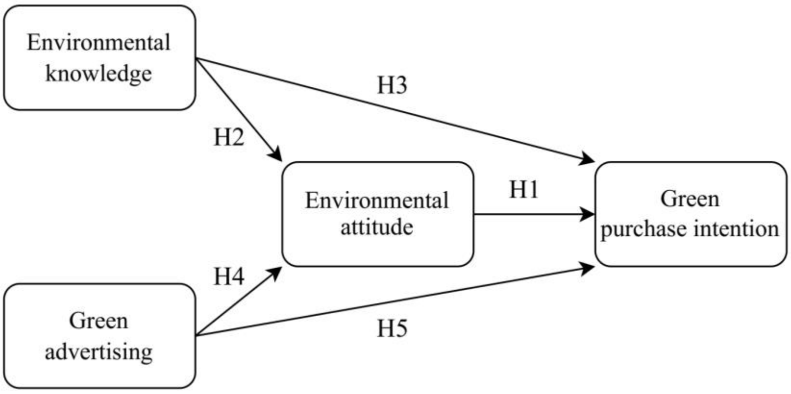

Figure 1: Research model

Source: Author

3. Methodology

3.1. Sampling procedures and participants

This study was designed to survey 250 customers at major shopping malls in Ho Chi Minh City, Vietnam. To ensure representativeness and gather data from a diverse customer base, the author employed a convenience sampling method. Specifically, the largest shopping malls in Ho Chi Minh City - Vincom Dong Khoi, Saigon Centre, SC Vivo City Shopping Center, Aeon Mall Tan Phu, and Crescent Mall - were randomly selected for the survey. This sampling approach allowed for the collection of information from various customer segments, providing a more comprehensive view of customer attitudes and behaviors. The convenience sampling process was conducted as follows: In April 2024, the author surveyed the selected locations by directly approaching customers at the shopping malls during peak hours (afternoons and evenings on weekends). Each customer was randomly invited to participate in the survey without any obligation, ensuring the voluntary and diverse nature of the sample. A total of 250 questionnaires were distributed, of which 241 valid responses were collected and used for the final analysis. The invalid questionnaires were primarily due to missing information or incomplete responses. The collected data were processed and encrypted to protect the personal information of the participants before conducting statistical analysis.

3.2. Measurement

- *Environmental knowledge:* Five items used for the green purchase intention scale were derived from Keller (1993)*:* (1) Going green with products could be a beneficial investment in the long term; (2) The green product's environmental performance meets my expectations; (3) Lack of availability and access is a major reason for the low popularity and demand of green products; (4) I purchase green products because they are environmentally friendly; and (5) I purchase green products because they have more environmental benefits than other products.

- *Green advertising:* The five-item scale from Hartmann et al. (2005): (1) I feel that the green product's environmental reputation is generally reliable; (2) I feel that the green product's environmental performance is generally dependable; (3) I feel that the green product's environmental claims are generally trustworthy; (4) Green product's environmental concern meets my expectations; and (5) Solving societal problems is something each of us can contribute to.

- *Environmental attitude:* The five-item scale from Hartmann et al. (2005): (1) I feel that the green product's environmental reputation is generally reliable; (2) I feel that the green product's environmental performance is generally dependable; (3) I feel that the green product's environmental claims are generally trustworthy; (4) Green product's environmental concern meets my expectations; and (5) Solving societal problems is something each of us can contribute to.

- *Green purchase intention:* Five items used for the green purchase intention scale were derived from Mohd Suki (2016)*:* (1) I intend to buy green products because of their environmental concern; (2) I expect to purchase green products in the future because of their environmental benefits; and (3) Overall, I am glad to purchase green products because they are environmentally friendly.

3.3. Method of data analysis

Both measurement and structural models were empirically tested by the Partial Least Squares (PLS) approach. PLS is suitable for our research model because it emphasizes exploration and prediction (Hair Jr et al. 2016). The procedure for data analysis consists of (1) the evaluation of the collinearity and standard method bias, (2) the assessment of the reliability and validity of the measurement model, (3) the evaluation of the structural model, and (4) the evaluation of the sequential mediating effects.

4. Results

4.1. Demographic information of respondents

Demographic information of respondents is described in the Table 1.

Table 1: Demographic information of respondents

Variable	Frequency	Percentage (%)
Gender		
Male	99	41.07
Female	142	58.92
Age		
22-30	84	34.85
30-40	96	39.83
40+	61	24.90

Source: Author's data analysis

4.2. Measurement model

The reliability and convergent validity were measured by using Cronbach's alpha and composite reliability (CR) and average variance extracted (AVE) (Hair & Alamer, 2022). Cronbach's alpha and composite reliability values for all the constructs were above the threshold value of 0.7 (Hair & Alamer, 2022), while factor loadings and AVE were above the threshold of 0.5 (see Table 2); together, these results confirmed the reliability and validity of all constructs in the model.

Table 2: Construct reliability and convergent validity

Construct	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Environmental attitude	0.881	0.905	0.514
Green purchase intention	0.888	0.915	0.642
Environmental knowledge	0.856	0.893	0.584
Green advertising	0.838	0.908	0.756

Source: Auhor's data analysis

Discriminant validity was tested using the g two criteria: Fornell and Larcker (1981) criteria and heterotrait-monotrait (HTMT) ratio of correlations. First, the square root of the AVE value for each structure should be larger than the shared relationship coefficients to establish the discriminant validity of the factors in the model. Secondly, all HTMT values were lower than the threshold value of 0.90, and neither the lower nor upper confidence interval (CI) included a value of 1 (Henseler et al., 2015) (see Table 3). Thus, both convergent and discriminant validity were established for this measurement model.

Table 3: Correlation, the square roots of AVE, and Heterotrait-Monotrait (HTMT) ratio

Construct	1	2	3	4
1. Environmental attitude	**0.717**	0.339	0.302	0.186
2. Environmental knowledge	0.337	**0.801**	0.209	0.265
3. Green advertising	0.327	0.156	**0.764**	0.217
4. Green purchase intention	0.128	0.224	0.173	**0.869**

Note: *Correlations and Heterotrait-Monotrait ratio are at the lower and upper of the diagonal, respectively; the square roots of AVE are highlighted in bold.*

Source: Auhor's data analysis

4.3. Structural model

The adjusted R^2 values of environmental attitude and green purchase intention were 0.245 and 0.362, respectively, which are greater than the minimum recommended value of 0.2 (Cohen, 2013), which is considered acceptable (Hair & Alamer, 2022). A t-test calculated from the bootstrapping process of 5,000 samples was applied to test the direct effects (see Table 4). The research results indicate that environmental attitude and green advertising positively impact green purchase intention. Additionally, environmental knowledge also has a positive effect on environmental attitude; therefore, hypotheses H1, H2, and H4 are accepted. However, environmental knowledge and green advertising do not have an impact on green purchase intention; hence, hypotheses H3 and H5 are rejected.

Table 4: Research results

Hypotheses		Path	p-value	Supported
H1	Environmental attitude ➔ Green purchase intention	0.212	0.000	Yes
H2	Environmental knowledge ➔ Environmental attitude	0.121	0.000	Yes
H3	Environmental knowledge ➔ Green purchase intention	0.432	0.210	No

Hypotheses		Path	p-value	Supported
H4	Green advertising → Environmental attitude	0.112	0.004	Yes
H5	Green advertising → Green purchase intention	0.167	0.512	No

Source: Auhor's data analysis

5. Discussion and Implications

5.1. Discussion

The results confirm a positive impact of environmental attitude on green Purchase Intention (p-value = 0.000), which aligns with previous studies such as Ferraz et al. (2017) and Datta (2011). These studies also found that a solid pro-environmental attitude enhances the likelihood of consumers choosing green products. The consistency in findings can be attributed to the Theory of Planned Behavior, which posits that attitudes significantly shape intentions and behaviors (Ajzen, 1991). Individuals with a positive attitude toward environmental conservation are more likely to engage in behaviors that reflect their environmental values, such as purchasing eco-friendly products. The positive effect of environmental knowledge on environmental attitude (p-value = 0.000) is also supported, consistent with findings by Aminrad et al. (2013) and Janmaimool and Khajohnmanee (2019). These studies suggest that individuals with more excellent environmental knowledge are more likely to develop positive attitudes towards environmental protection. Knowledge provides a foundation for understanding environmental challenges, which fosters a commitment to sustainability. This alignment highlights the importance of environmental education in shaping attitudes and promoting pro-environmental behaviors. The hypothesis that environmental knowledge directly influences green purchase intention is not supported (p-value = 0.210). This result diverges from some earlier studies, such as which suggested that informed consumers are more likely to make green purchasing decisions. The discrepancy may be due to the presence of intervening factors like perceived product quality, cost, and effectiveness. Knowledge alone may only be sufficient to drive purchasing decisions if it is paired with favorable perceptions of the product or solid personal values. The positive impact of green advertising on environmental attitude (p-value = 0.004) aligns with previous research by Zaremohzzabieh et al. (2021). These studies demonstrate that green advertising effectively raises awareness about environmental issues and promotes the benefits of sustainable choices. Green Advertising emphasizes a company's commitment to sustainability, which helps build trust and enhances positive attitudes towards the environment (Nyilasy et al., 2014). The hypothesis that green advertising directly impacts green purchase intention is also not supported (p-value = 0.512). This finding contradicts research by Khandelwal and Bajpai (2011), which indicated that credible green advertising could enhance green purchase intentions. The lack of significance in this study could be due to consumer skepticism regarding greenwashing or the authenticity of green claims. Consumers may require more than just advertising messages to change their purchasing behavior; they might need evidence of a company's genuine commitment to sustainability and tangible product benefits.

5.2. Implications

For businesses, especially those dealing with eco-friendly products, fostering a positive Environmental Attitude is key to increasing green purchase intention. Since Environmental attitude significantly impacts consumers' intention to buy green products, companies should focus on strategies that promote positive attitudes toward environmental conservation. This can be achieved through clear communication of their products' environmental benefits and demonstrating a genuine commitment to sustainability, such as through CSR activities like reducing carbon footprints and promoting recycling. These efforts build trust and credibility, which are crucial in influencing purchasing decisions. Policymakers should recognize the critical role of environmental knowledge in shaping positive environmental attitudes. Enhancing public awareness and understanding of environmental issues is essential. This can be achieved by prioritizing environmental education initiatives, from schools to public awareness campaigns, to educate citizens about the causes and consequences of environmental degradation and the benefits of sustainable practices. Additionally, policies that promote transparency in green marketing and protect against greenwashing can build consumer trust in green claims, supporting sustainable consumption. Marketers should adopt a more nuanced approach to green advertising. While it positively affects Environmental Attitude, it does not directly lead to green purchase intention. Marketers need to focus on building credibility and trust through transparent and verifiable green claims aligned with the company's sustainability goals. Integrating green messaging with strategies like influencer endorsements, social proof, and community engagement can further reinforce the authenticity of green initiatives. Compelling storytelling that resonates with consumers' values can also enhance the impact of green advertising on consumer behavior.

6. Conclusion

The study concludes that environmental attitude plays a crucial role in shaping green purchase intentions among consumers in Ho Chi Minh City. While environmental knowledge and green advertising positively influence environmental attitudes, their direct impact on green purchase intention is limited. This suggests that fostering a robust pro-environmental attitude is essential for encouraging green consumer behaviors. Still, it may only be sufficient with addressing other factors such as product quality perceptions and credibility of green claims. Companies should focus on building trust and transparency in their green marketing efforts, ensuring that their environmental claims are genuine and supported by sustainable practices. Additionally, enhancing environmental knowledge through targeted educational initiatives can further reinforce positive attitudes toward sustainability. Future research should explore the interplay of these factors in different contexts to develop more effective strategies for promoting green consumption.

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Promote Voluntary Environmental Protection Behavior of Employees at Road Transport Companies

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Abstract

Voluntary behavior is one of the important factors in creating success for environmental protection strategies. One of the most significant stakeholders that make environmental protection efforts at road transport companies successful is their employees. This study aims to understand the voluntary environmental protection behavior of employees under the impact of awareness of climate change, environmental responsibility, and perceived risk of climate change. Based on the protection motivation theory to explain the relationship between variables, the study collected 442 responses from employees working at road transport companies using a non-probability, convenience sampling method. Testing results using PLS-SEM show that awareness of climate change and environmental responsibility have a positive effect on environmental protection behavior. The relationship between environmental protection behavior and awareness of climate change is mediated by environmental responsibility. Then, the author proposed solutions to help road transport companies promote voluntary environmental protection behavior among workers to achieve sustainable development goals.

Keywords: *Awareness; environmental protection behavior; environmental responsibility; perceived risk; transportation*

1. Introduction

Environmental protection behavior is not just a communal duty but also an urgent personal obligation in light of the increasingly severe effects of climate change (Jilani et al., 2021). Since climate change has major effects on the planet, like rising sea levels, harmful effects from greenhouse gas emissions, and the depletion of natural resources, humans must take this seriously (Chaudhary, 2020). Research on environmental protection behavior has drawn interest from a wide range of stakeholders, including the general public, corporations, and consumers, ever since.

The road transportation industry is one of the most polluting industries (Matubatuba & De Meyer-Heydenrych, 2022). The companies in the industry operations use fossil fuels such as gasoline, diesel, and coal. This fuel combustion process produces emissions, contributing to increased greenhouse gases in the air and causing air pollution (Leonnard et al., 2017). Building and developing road transport infrastructure is essential to facilitating transportation. This requires a sizable amount of land and has the potential to destroy the ecosystem, decreasing the amount of fields, forests, and animal habitats. Moreover, vehicles pollute the air with harmful substances like dust and fine particles and produce noise, which is bad for both human health and the environment (Afroz et al., 2015). Therefore, researching solutions to promote environmental protection behavior in the road transport industry is necessary.

While lessening the impacts of climate change is a shared responsibility for the community, employees also play a significant role. They play a direct role in lessening adverse effects on the environment, but they also play an indirect role by telling customers about the company's environmental protection campaigns (Whitmarsh et al., 2021). Transferring knowledge will be very effective, particularly if employees are knowledgeable about environmental risks and environmental responsibility (Venghaus et al., 2022). Previous studies show that some of the important factors that influence employees' environmental protection behavior are awareness, risk perception, and responsibility for the environment (Yilmaz et al., 2023). The relationship between awareness of climate change and environmental protection behavior is also mediated by environmental responsibility and perceived risk of climate change, as previous research has confirmed (Yu et al., 2017).

Having contributed a noteworthy 4.5% of the nation's GDP, Vietnam's road transport and warehousing sector has become one of the ASEAN region's most appealing investment opportunities (Thơm, 2020). There is a rise in the number of new businesses and significant growth potential in the transportation sector. Given this circumstance, Vietnam faces an even greater risk of environmental pollution, particularly given that it is among the top ten countries in the ASEAN region for pollution (Thia, 2019). As a result, studies on how Vietnamese companies in the road transport sector protect the environment are crucial at this time.

While some earlier research has examined individual environmental protection behavior, the majority of the studies were on students (Yilmaz et al., 2023; Yu et al., 2017; Dal et al., 2015). This study is based on protection motivation theory, focusing on employees at road transport enterprises to examine environmental protection behavior under the impact of awareness of climate change, environmental responsibility, and perceived risk of climate change. The research also studies the mediating effects of environmental responsibility and the perceived risk of climate change in the relationship between awareness of climate change and environmental protection behavior. Consequently, this study will contribute to a better understanding of how employees of road transport companies behave when it comes to environmental protection. Administrators will be able to make policies that encourage employee environmental protection behavior with the help of empirical evidence from the research results.

2. Literature review

2.1. Protection motivation theory

To explain predictors of risk-prevention behaviors, Rogers introduced the Protection motivation theory in 1975 (Bockarjova & Steg, 2014). The theory is a broadly applicable theoretical framework. The theory posits that individuals weigh various advantages and disadvantages when making decisions. It's not always necessary for this process of consideration and judgment to be explicit and occur within conscious awareness (Shafiei & Maleksaeidi, 2020).

People choose to engage in a certain behavior after weighing the benefits and drawbacks of various options and determining which is best for them. This kind of comparison is carried out using the "threat appraisal" and "coping appraisal" processes (Wang et al., 2018). The cognitive process of "threat appraisal" starts with the level of threat and includes "perceived severity" and "perceived vulnerability" (Boer & Seydel, 1996). The degree of potential harm that an individual perceives as serious is known as the perceived severity of the threat, and the perception of one's susceptibility to harm is known as perceived vulnerability (Bockarjova & Steg, 2014). People use the "threat appraisal" process to evaluate the advantages or rewards of their current behavior.

Protection motivation theory is now frequently used to describe pro-environmental behaviors (Shafiei & Maleksaeidi, 2020). Because it illustrates how various psychological processes and mechanisms can interact and serves as a reminder that these processes and mechanisms can all simultaneously lead to misestimation and inaction, this theory is especially helpful in the analysis of pro-environmental behaviors (Bockarjova & Steg, 2014). This theory is applied in this study to assess the degree of awareness and perceived risk that motivates environmental protection behavior under the influence of environmental responsibility and the perceived risk of climate change.

2.2. Hypothesis and Research model

Environmental protection behavior is defined as actions that either help the environment or at least cause the least amount of harm to it. These behaviors are typically carried out at the individual or household level (Bradley et al., 2020). This behavior performed in the corporate environment is an important aspect of promoting the sustainable development of businesses (Xie et al., 2019). Environmentally friendly actions at businesses are carried out in two aspects (Cheema et al., 2020). First, there are certain procedures that all employees in the company must adhere to. Secondly, voluntary actions are not always taken. Employees will take action when they feel compelled to, according to the protection motivation theory. When people perceive that the health and lives of future generations are at risk due to climate change, they act voluntarily. The activities of road transport companies cause high pollution (Zailani et al., 2014). To promote sustainable development, environmental protection behavior needs to be implemented in both voluntary and mandatory aspects. This theory is used in this study to explain people's motivation to perform voluntary environmental protection behavior stemming from awareness of the harmful effects of environmental pollution.

Climate change awareness can be defined as the degree to recognize, comprehend, and value climate change as a factor driving changes in bio-agronomic systems (Abbasi & Nawaz, 2020). To create a better quality environment, raising awareness of climate change involves expanding knowledge, developing values, changing attitudes, and developing skills and abilities (Shafiei & Maleksaeidi, 2020). It's commonly believed that educating about the causes of climate change is the first step, even though education by itself doesn't alter behavior. Nonetheless, it has been determined that awareness is a crucial component in tackling the climate change issue (Halady & Rao, 2010).

To mitigate climate change, raising awareness of it is essential in road transport companies (Yilmaz et al., 2023). Utilizing solar energy, cutting back on gasoline consumption, investing in variable funds, increasing reduction, reuse, recycling, and contributing to climate change movements are examples of environmentally friendly behaviors that promote environmental protection (Halady & Rao, 2010). Previous studies have shown that climate change awareness has a positive impact on environmental protection behavior (Halady & Rao, 2010; Dal et al., 2015). However, there is also research that has found that climate change awareness has a negative impact on pro-environmental behavior (Lacroix & Gifford, 2018). This results from both competitive incentives and the high financial costs associated with environmental protection. Conversely, proponents of environmental protection behavior contend that employees act to protect the environment for two reasons: obligatory and voluntary. This study primarily concentrates on awareness because it examines employees' voluntary behavior. From there, the subsequent research hypothesis is proposed:

H1. Awareness of climate change has a positive impact on environmental protection behavior.

One of the main focuses of studies on behavior related to environmental protection is the perceived risk of climate change (Bradley et al., 2020). Because the road transport sector is the one that directly contributes to environmental pollution, this issue is particularly significant to it (Zailani et al., 2014). Perceived risk of climate change is the process of identifying and evaluating signals about uncertain occurrences from a variety of sources, as well as creating an opinion about the likelihood and seriousness of present or potential harm (Stevenson et al., 2014). Risk perception of climate change has typically been quantified as an evaluation of the possible local, regional, and global health, economic, and environmental consequences of climate change (Arbuckle et al., 2015).

Both ecosystems and people are seriously at risk from climate change (Venghaus et al., 2022). Since there are many different kinds, variations, and haphazard connections among environmental protection behavior, it is important to comprehend the causes and effects of this behavior (Kousar et al., 2022). Previous research has confirmed that awareness of climate change has an impact on the perceived risk of climate change (Bockarjova & Steg, 2014); (Abbasi & Nawaz, 2020). Noting that different people may have varying perceptions of the risks posed by climate change is also crucial (Arbuckle et al., 2015). Nonetheless, in addition to the previously mentioned elements, people's perception of risk will increase when they are highly aware of climate change (Yilmaz et al., 2023). The following research hypothesis is then put forth.

H2. Perceived risk of climate change is positively impacted by climate change awareness.

Perceived risk encompasses not only the awareness of objective threats but also other elements like social and personal factors, which include the risks associated with climate change (Bradley et al., 2020). Employee's perception of the risk posed by climate change arises from their awareness of the phenomenon, their observation of its symptoms, or their sense that the planet is warming and that this has an impact on human health (Hidalgo et al., 2010).

Even though numerous studies have demonstrated the negative impacts of climate change on the environment (Arbuckle et al., 2015); (Khan et al., 2021), employee's perceptions of risk vary due to differences in knowledge (Hidalgo et al., 2010). According to protection motivation theory, people will take their actions after evaluating the threats and feeling the severity of the problem (Boer & Seydel, 1996). When the threat of climate change is sufficiently felt, people will act more environmentally (Yu et al., 2017). Furthermore, the perceived risk of climate change is found to have the biggest influence on behavior related to protecting the environment (Arbuckle et al., 2015). From there, the following research hypothesis is proposed

H3. Perceived risk of climate change has a positive impact on environmental protection behavior.

Responsibility is one of three elements of corporate social responsibility. Environmental responsibility is actions to protect the environment performed by humans. These actions are performed voluntarily and are not rewarded or required by the organization's formal reward system (Han et al., 2019). According to Fatma et al. (2016), care and preservation of the natural environment, low use of natural resources, the use of renewable energy sources, and a propensity to purchase ecologically friendly products are indicators of one's responsibility to the environment. It reflects personal moral convictions and endeavors to improve sustainable management while balancing the relationship between human society and the natural world (Abbasi & Nawaz, 2020). Despite being voluntary, this contributes significantly to the business's environmental protection strategy as well as the community (Kousar et al., 2022).

Strengthening corporate social responsibility is becoming more and more important because transport companies' operations have a direct impact on communities, employees, consumers, and the environment (Thơm, 2020). Previous research results have shown that awareness of climate change has a positive effect on environmental responsibility (Jamelske et al., 2013; Yilmaz et al., 2023). As awareness of the certainty of future climate change increases, respondents' behavior toward implementing policies to reduce climate change also increases (Jamelske et al., 2013). This shows that awareness influences environmental responsibility. From there, the following research hypothesis is proposed:

H4. Awareness of climate change has a positive impact on environmental responsibility.

Being environmentally conscious is a way that businesses can get an advantage in the current competitive market (Liu et al., 2020). Businesses have since encouraged employees to act morally (Loor-Zambrano et al., 2022). Acting responsibly towards the environment voluntarily is also a way for them to positively influence the organization (Ahmad et al., 2021). Therefore, an environmentally responsible organization can become a suitable place for employees to engage, distinguish themselves from others, and voluntarily participate in the organization's environmental programs and activities (Xie et al., 2019). Furthermore, employees will develop a stronger sense of loyalty to road transport companies that develop and put into action environmental improvement and protection strategies. They respond by helping colleagues better integrate environmental concerns and propose new ways to protect the environment (Cheema et al., 2020).

Employees take part in environmental initiatives addressing and advancing environmental sustainability (Cheema et al., 2020). Previous research has shown that responsibility toward the environment has a positive impact on environmental protection behavior (Yilmaz et al., 2023). Environmentally conscious people believe that actions like eco-friendly shopping, preserving the environment, saving energy, coming up with suggestions for how to make the environment better, and properly disposing of waste are carried out both at home and at work (Venghaus et al., 2022). From there, the following research hypothesis is proposed:

H5. Environmental responsibility has a positive impact on environmental protection behavior.

While pro-environmental behavior is influenced by climate change awareness, it is crucial that perceptions of the risk posed by climate change can differ depending on one's knowledge and awareness of this phenomenon (Drummond et al., 2018). The elements that make up the perceived risk of climate change demonstrate the need for employees to possess information, experience, and the ability to respond emotionally to outside influences (Dal et al., 2015). In the road transport company, the more the relationship between awareness of climate change and environmental protection behavior is strengthened (Yilmaz et al., 2023). Therefore, perceived risk is confirmed to have a positive mediating role (Han et al., 2019). From there, the following research hypothesis is proposed:

H6. perceived risk of climate change has a positive mediating role in the relationship between awareness of climate change and environmental protection behavior.

Under pressure to protect the environment, the Government has introduced many regulations to reduce climate change (Afsar & Umrani, 2020). Businesses have since employed corporate social responsibility (CSR) as a solution for this issue (Yu et al., 2017). When awareness of CSR activities including environmental responsibility is increased, positive behaviors will be triggered in employees (Allen & Craig, 2016). By learning and sharing environmental values, environmental responsibility will be promoted, and employees will also show environmentally friendly tendencies (Ahmad et al., 2021). The study by Han et al. (2019) has argued that employees' perceptions of climate change influence their engagement in environmental behaviors through mediating perceived responsibility for those behaviors.

H7. Environmental responsibility plays an intermediary role in the relationship between awareness of climate change and environmental protection behavior.

The research model is then suggested as follows:

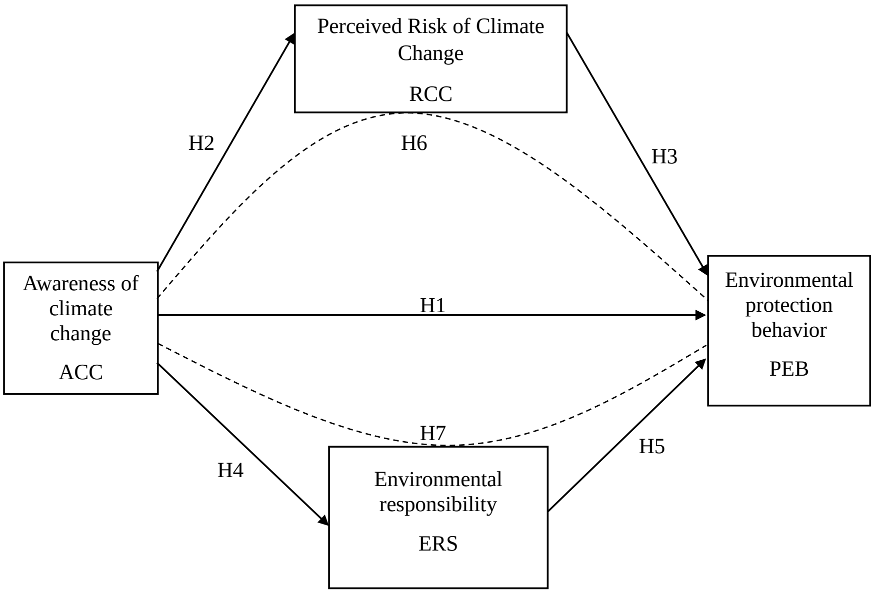

Figure 1: Research model

Source: Author

3. Methodology

3.1. Research process

The research process is carried out in two stages: (1) Researching documents and proposing models, and (2) Adjusting the scale and quantitative research. To suggest a research model, the authors reviewed relevant literature and theory. Create a scale, hold group discussions, finish and adjust the official scale, and create a questionnaire after that. Next, gather information by surveying employees at road transport companies in Vietnam. The software SmartPLS 4.0 was used to clean and analyze the acquired data to assess the measurement and structural models. Lastly, discuss the research findings and offer management implications.

3.2. Measurement

The study used the scale of Halady & Rao (2010) to measure Awareness of climate change of employees, including 8 observed variables. The environmental responsibility scale is referenced from the study of Fatma et al. (2016), including 6 observed variables. The perceived risk of climate change scale is taken from the study of Hidalgo et al. (2010), including 8 observed variables; the Environmental protection behavior scale is referenced from the study of Shafiei & Maleksaeidi (2020), including 3 observed variables. Details of the questionnaire items are measured on a 5-point Likert scale with 1 being completely disagree and 5 being completely agree (Table 1).

3.3. Data collection

Data were collected using questionnaires. The author used a convenience sampling method, sending surveys to managers and employees working at businesses at road transport companies in Vietnam. The questionnaire was created using Google Forms and delivered to respondents using a link or QR code. This data collection method also makes it easier to collect responses and enter data into SmartPLS 4.0 software.

The questionnaire was tested by testing 45 people before sending it to the survey. The purpose of the test survey is to make the question's meaning clear, without confusion about sentences and words leading to misunderstanding the meaning of the question (Collins, 2003). In SEM analysis, there is no minimum sample quantity standard. However, according to Reinartz et al. (2009), when the sample size is greater than 100, the statistical power is at an acceptable level. The higher the sample size, the more accurate the estimate. Therefore, the author conducted a survey of 450 people and the results were 442 valid responses, a response rate of 98%. The high response rate can be attributed to the fact that most respondents were willing to support.

3.4. Research method

The study uses quantitative methods to test the model and hypotheses. Partial least squares linear structural modeling (PLS-SEM) analysis is used in this study because it is a method with high prediction accuracy, suitable for business research, and provides implications for management. The reflective model is used because the observed variables in this study are results created from latent variables (Hair et al., 2012). There are two stages involved in evaluating the measurement model and the structural model. The first stage is to evaluate the measurement model, specifically to evaluate factor loadings, evaluate reliability, evaluate convergence, and discriminant validity. The second stage is to evaluate the structural model, specifically evaluating the multicollinearity phenomenon, and path coefficients, evaluating the R^2 coefficient, the magnitude of the effect, and the Q^2 coefficient.

4. Results

4.1. Descriptive statistics

The survey was conducted for 6 months, from July 2023 to January 2024. The respondents to the survey were employees of road Vietnamese transportation firms. Leaders and employees are among the survey participants. The author carried out surveys in the North, Central, and South regions to guarantee the sample's representativeness, whereby the survey rates are 30% in Hanoi (the northern region), 10% in Da Nang (the central region), and 60% in Ho Chi Minh City (the southern region). Aiming to ensure the representativeness of the sample, the author gathered 442 appropriate samples for analysis by distributing data collection.

Table 1: Description of sample characteristics

Demographics Content		Number of responses	Percentage of responses (%)
Gender	Male	292	66
	Female	150	34
Age	<36	106	24
	36 – 40	128	29
	41 – 45	124	28
	46 – 50	80	18
	>50	4	1
Job position	Leader	216	49
	Staff	226	51
Job experience	<5	84	19
	5-10	141	32
	11-15	119	27
	>15	98	22
Total		442	100

Source: Statistics from the survey sample

4.2. Evaluate the measurement model

Table 2 shows the outer loading results of all observed variables measuring 4 concepts (awareness of climate change, environmental responsibility, perceived risk of climate change, protect environment behavior). Since the outer loading coefficients were higher than 0.708, all observed variables were kept (Hair et al., 2014). Thus, all observed variables used to measure four concepts meet the threshold.

Table 2: Outer loading results

Variable symbol	Conceptual structure	Outer Loading
Awareness of climate change (ACC) (Source: Halady & Rao, 2010)		
ACC1	I am aware of how climate change affects human health.	0.823
ACC2	I am conscious of the effects of sea level rise.	0.720
ACC3	I am aware of certain people's efforts to save energy.	0.800
ACC4	I am aware that driving a car with less house gas is possible.	0.749
ACC5	I am aware of industry-wide efforts to use solar energy to save energy.	0.802
ACC6	I am aware of the industry utilizing materials and technology that are pro-climate change	0.792
ACC7	I am aware of the shift in behavior due to climate change.	0.755
ACC8	I know of the leading initiative against climate change.	0.763
Environmental responsibility (ERS) (Source: Fatma et al., 2016)		
ERS1	I use renewable energy in an environmentally friendly and productive manner.	0.776
ERS2	My concern is for the preservation and observance of the natural world.	0.707
ERS3	I'm willing to use, buy, or produce environmentally friendly products.	0.758
ERS4	I cut back on my use of natural resources.	0.815
ERS5	I discuss environmental practices with my customers.	0.781
ERS6	I take part in the environmental certification program.	0.780
Perceived risk of climate change (RCC) (Source: Hidalgo et al., 2010)		
RCC1	I believe that we are currently experiencing climate change.	0.707
RCC2	Some of the symptoms of climate change are already apparent to me.	0.753
RCC3	I believe that this year's temperature is higher than last year's.	0.728
RCC4	Rainfall has probably decreased recently.	0.737
RCC5	There has been an increase in abrupt, unforeseen changes and general climate variability.	0.826
RCC6	There will be some beneficial effects of climate change on the climate.	0.848
RCC7	There will be some benefits to climate change for the sea and ice caps.	0.776
RCC8	There will be some benefits to human health from climate change.	0.721
Environmental protection behavior (PEB) (Source: Shafiei & Maleksaeidi, 2020)		
PEB1	Thus far, I have participated in environmental conservation initiatives like planting trees, separating waste, and recycling.	0.851
PEB2	I make an effort to conserve energy	0.913
PEB3	I am actively engaged in expanding the environmental information regarding my surroundings.	0.827

Source: Analysis from SmartPLS 4.0 software

The results in Table 3 show that all scales have Cronbach's Alpha greater than 0.7, the reliability of the scales is greater than 0.7 and less than 0.95, and the extracted variances are greater. 0.5 (Hair et al., 2021). The scales achieved reliability and convergent validity.

Table 3: Reliability and convergent validity

Concept	Cronbach's Alpha	CR	AVE
Awareness of climate change (ACC)	0.905	0.907	0.602
Environmental responsibility (ERS)	0.864	0.872	0.593
Perceived risk of climate change (RCC)	0.830	0.840	0.747
Environmental protection behavior (PEB)	0.897	0.901	0.583

Source: Analysis from SmartPLS 4.0 software

Table 3 also show that the smallest square root value of AVE (0.770) is larger than the largest value of concept pair correlation (0.763); Table 4 shows that the HTMT indexes between independent variables are all less than 0.9 (Hair et al., 2021).

Table 4: Results of Fornell-Larcker test

	ACC	ERS	PEB	RCC
ACC	0.786			
ERS	0.763	0.776		
PEB	0.554	0.586	0.864	
RCC	0.770	0.722	0.467	0.770

Abbreviation: ACC, awareness of climate change; ERS, Environmental responsibility; PEB, Environmental protection behavior; RCC, perceived risk of climate change

Source: Analysis from SmartPLS 4.0 software

Table 5: Results of the HTMT test

	ACC	ERS	PEB	RCC
ACC				
ERS	0.837			
PEB	0.635	0.667		
RCC	0.747	0.804	0.529	

Abbreviation: ACC, awareness of climate change; ERS, Environmental responsibility; PEB, Environmental protection behavior; RCC, perceived risk of climate change

Source: Analysis from SmartPLS 4.0 software

4.3. Evaluate the structural model

The largest VIF value, which is less than 3 (Hair et al., 2021), is 2.863 according to the SmartPLS analysis results. Table 6 shows that multicollinearity is absent from the model.

Table 6: Results of VIF

	ACC	ERS	PEB	RCC
ACC		1.000	2.373	1.000
ERS			2.863	
PEB				
RCC			2.699	

Abbreviation: ACC, awareness of climate change; ERS, Environmental responsibility; PEB, Environmental protection behavior; RCC, perceived risk of climate change

Source: Analysis from SmartPLS 4.0 software

This study tests the positive effects of awareness of climate change on (1) Perceived risk of climate change; (2) environmental responsibility; and (3) Environmental protection behavior. At the same time, the study also tested the mediating role of perceived risk of climate change and environmental responsibility between awareness of climate change and environmental protection behavior.

The threshold for evaluating the PLS-SEM model as well as the hypothesis is based on the suggestions of Hair et al. (2021). The R^2 and Q^2 results in Table 7 show that the structural model has good quality. Furthermore, the path coefficients related to the impact of awareness of climate change on the responsible environment, perceived risk of climate change, and environmental protection behavior are significant at 5% significance. The data indicates that awareness of climate change has the strongest impact on the perceived risk of climate change (β = 0.090). It also has an impact on environmental responsibility (β = 0.024) and environmental protection behavior (β = 0.020). The findings also indicate that the perceived risk of climate change is influenced by environmental responsibility (β = 0.075). The study's findings, however, indicate that environmental protection behavior is unaffected by the perceived risk of climate change.

Table 7: Results of testing the direct relationship

Hypothesis		Standard deviation (STDEV)	t-value	p-value	Conclusion
ACC -> ERS	H4	0.024	33.120	0.000	Accept
ACC -> PEB	H1	0.090	2.849	0.004	Accept
ACC -> RCC	H2	0.020	38.037	0.000	Accept
ERS -> PEB	H5	0.075	5.263	0.000	Accept
RCC -> PEB	H3	0.072	0.220	0.826	Not accept
R^2	R^2_{ERS} = 0.617; R^2_{PEB} = 0.367; R^2_{RCC}= 0.594				
f^2	$f^2_{ACC \to ERS}$ = 1.612; $f^2_{ACC \to PEB}$ = 0.103; $f^2_{ACC \to RCC}$= 1.462; $f^2_{ERS \to PEB}$= 0.186; $f^2_{RCC \to PEB}$= 0.000				
Q^2	Q^2_{ERS} = 0.359; Q^2_{ACC} = 0.000; Q^2_{PEB} = 0.259; Q^2_{RCC} = 0.337				

Abbreviation: ACC, awareness of climate change; ERS, Environmental responsibility; PEB, Environmental protection behavior; RCC, perceived risk of climate change

Source: Analysis from SmartPLS 4.0 software

Table 8: Results of testing the effect of intermediate variables

Hypothesis		Standard deviation (STDEV)	t-value	p-value	Conclusion
ACC -> ERS -> PEB	H7	0.062	4.995	0.000	Accept
ACC -> RCC -> PEB	H6	0.056	0.220	0.826	Not accept

Abbreviation: ACC, awareness of climate change; ERS, Environmental responsibility; PEB, Environmental protection behavior; RCC, perceived risk of climate change

Source: Analysis from SmartPLS 4.0 software

According to Table 8, environmental responsibility also mediates the relationship between awareness of climate change and environmental protection behavior (β = 0.062), and the significance of this mediating relationship is indicated by a p-value of less than 0.05. Nevertheless, the hypothesis regarding the perceived risk of climate change's mediating role on the association between climate change awareness and environmental protection behavior is unsupported (p-value > 0.05, indicating that this mediating relationship is not supported). So, hypothesis H7 is supported but hypothesis H6 is not supported.

5. Discussion

According to protection motivation theory, people will act when they perceive threats and realize how serious the risks are (Wang et al., 2018). Previous studies have shown that awareness of climate change and the Perceived risk of climate change have an impact on Environmental protection behavior (Jamelske et al., 2013); (Yilmaz et al., 2023); (Yilmaz et al., 2023). The results of research in Vietnamese road transport companies only confirm the impact of awareness of climate change on Environmental protection behavior. When employees' awareness increases, environmental protection behavior tends to increase. This result is consistent with the theoretical framework, however, in the Vietnamese context, the perceived risk of climate change has not had an impact on environmental protection behavior. This can be explained by the influence of competition and costs in environmental protection (Lacroix & Gifford, 2018). Business policies do not encourage employees to take environmental protection measures, even though they are aware of the risks posed by climate change.

Furthermore, the test results indicate that environmental protection behavior is influenced by awareness of climate change and environmental responsibility. This result is compatible with the results of previous studies (Jamelske et al., 2013); (Yilmaz et al., 2023). When employees' environmental responsibility increases, environmental protection behavior increases. Furthermore, there is a positive correlation between environmental responsibility and climate change awareness as well as environmental protection behavior. This result is similar to the study of Han et al. (2019).

The research results have contributed to the Protection motivation theory in determining the influence of awareness of climate change and environmental responsibility on environmental protection behavior related to the behavior of employees in the transportation industry. The novelty of the study is also shown by confirming the mediating role of environmental responsibility in the above relationship.

6. Conclusion and Implications

The findings have satisfied the following objectives: (1) Assess the relationship between environmental protection behavior and awareness of climate change; (2) Evaluate the mediating role of environmental responsibility and perceived risk of climate change in the relationship between awareness of climate change and environmental protection behavior. However, the study has limitations due to the non-probability, convenience sampling method. Future studies should perform probability sampling, and the research results will better test the relationship in the population.

In order to implement more ecologically friendly practices, employees in the road transportation sector need to understand the impact of climate change. Businesses can plan informational campaigns or strategies regarding the effects of greenhouse gas emissions and rising sea levels. Organizing periodic training programs and seminars is necessary. They will provide employees with extensive knowledge of environmental issues, from negative industry impacts to effective environmental protection measures. Employees will learn the value of preserving the environment and how individual actions affect the natural order as a result of this. Furthermore, programs promoting energy efficiency and the use of alternative materials can be supported.

Companies must come up with ways to encourage employees to voluntarily take on more environmental responsibility in addition to requiring them to participate in environmental responsibility programs. Using renewable energy, preserving the environment, consuming fewer natural resources, taking part in environmental protection initiatives, and informing customers about climate change reduction programs are a few examples of these solutions. Besides, establishing a continuous feedback system is also key. Employees should be encouraged to submit comments, propose new ideas and discuss environmental issues within the organization. Through this, they will feel valued and contribute to building a responsible and environmentally sensitive working environment. Creating effective internal communication channels also plays an important role in sharing information and experience on environmental protection. From sharing successes to challenges, employees will learn from these experiences and feel more motivated to take actions to protect the environment.

7. Limitations

Even though the study makes some valuable contributions, its findings cannot be applied to the service sector or to other nations with distinct cultural norms and economic systems because the research sample was restricted to road transport companies and the survey was conducted only in Vietnam. Thus, more studies with a larger sample size and in different industries or regions should be carried out.

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Be Greener: Which Factors Affect Households' Intention to Switch to Producing Organic Incense in Traditional Craft Villages?

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Abstract

The business of organic products plays an important role in the pursuit of sustainable development, aiming for a carbon-free era. Therefore, studying the factors affecting households' intention to switch to producing organic incense is essential. The study surveyed a total of 117 households in Hai Duong and Thua Thien Hue, Vietnam. The authors used the fractional regression model to analyze and determine the key factors. The results indicate that all 5 groups of factors: perception factors, risk factors, output factors, financial factors, and control factors have a significant impact on households' intention. Based on the research results, several solutions for producers and policy implications for local authorities are proposed to enhance households' intention to switch to producing organic incense in traditional craft villages in the future.

Keywords: *Fractional regression model, households' intention, organic incense, traditional craft villages*

1. Introduction

In traditional craft villages, production causes environmental pollution issues (air pollution, water pollution, noise pollution, etc.). However, they have not been addressed specifically by the government, and there are no measures or sanctions similar to those applied to businesses and factories. And the craft village of incense making is the same. The process of producing incense by households causes air pollution when grinding the materials to create a powder. Not only that, according to Mr Vu Hoang Anh - Institute of Occupational Health and the Environment, marketed incense with chemical ingredients such as acid phosphoric and sulfur, when lit, incense produces multiple harmful chemical compounds like SO_2, CO, NO_2, and especially formaldehyde, compounds with heavy effects on humans' respiratory system.

Nowadays, sustainable production in traditional craft villages is increasingly being focused on and emphasized as the trend of sustainable development becomes a global standard. Previous studies have shown that sustainable production in traditional craft villages in Vietnam brings positive benefits to both the environment and the local economy (Doan, 2014; Triet, 2018; Bach et al., 2010). However, research on organic production for fragrance products in traditional craft villages such as Quoc Tuan (Hai Duong) and Thuy Xuan (Thua Thien Hue) is still very limited. Therefore, the group of authors is researching the topic of "Be Greener: Which factors affect households' intention to switch to producing organic incense in traditional craft villages?" This study focuses on analyzing the factors influencing the conversion intentions of production households in the two craft villages of Quoc Tuan and Thuy Xuan. Understanding the influencing factors will help in formulating policies and solutions to promote the transformation process, while also contributing to the preservation of the traditional values of craft villages and meeting the requirements for sustainable development. This research not only fills a gap in theory but also has high practical relevance, aligning with the current trend of sustainable economic development.

Based on the study of the factors influencing the intention to switch to the production of organic incense among households, the paper proposes some solutions for these households and suggest policies for local authorities to enhance their intention to produce organic incense in craft villages in the future.

2. Literature review and Hypothesis development

Al Mamun et al. (2018) noted that environmental concern has a positive effect on the attitude towards environmentally friendly products. Leonidou et al. (2019) also found that environmental public concern plays an instrumental role in harnessing an eco-friendly orientation within the small firm. Furthermore, Ms. Saina Jain's study (2020) illustrated the major environmental concerns regarding various factors that were influencing the producer's behavior, attitude, and producer's parameters of understanding the significance of Eco-friendly products and the production process. Li et al. (2020) noted that perceived value had significantly positive impacts on AGP willingness. Achmad et al. (2023) noted that government support indirectly influences eco-innovation adaptation and also highlighted that government support played an important role in promoting eco-innovation adaptation among SMEs in Indonesia. Hung & Thuyen (2022) also found that support policies have an impact on the intention to produce organic agriculture.

H1: Households with higher perception intent to produce organic incense more highly.

Different researchers have reported the impact of risk perception on people's behaviors. According to Li et al. (2022), risk perception and environmental regulation have significant effects on farmers' willingness to engage in sustainable behaviors. In terms of risk perception factor, economic risks create the greatest negative impacts. Hu et al. (2022) also found that risk perception has a negative impact on behavioral intention. Specifically, the higher the risk perception is, the less performance expectancy of green control techniques and the weaker the behavioral intention. Previously, O'Connor et al. (2006) noted that risk perceptions matter in predicting behavioral intentions. They are not a surrogate for general environmental beliefs but have their own power to account for behavioral intentions. Furthermore, Li et al. (2020) showed that perceived risks have a significantly negative impact on farmers' AGP willingness. On the contrary, a study by Maartensson & Loi (2021) revealed that risk perception was positively associated with behavioral willingness, risk perception, and behavioral willingness was positively associated with pro-environmental behavior, and constructive hope was positively associated with pro-environmental behavior.

H2: Risk perception has a significant impact on Households' intention to switch to producing organic incense.

The factors influencing households' intention to produce green production in Chinese medicinal herb growing include the output market, as highlighted in the research. Specifically, the study emphasizes the importance of market factors, along with other determinants like age, income, and knowledge transfer ability, in promoting sustainable practices among farmers (Liu et al., 2023). In addition, a study on the influencing factor for farming households' green vegetable production showed that there is a negative relationship between green vegetable production costs and farmers' production behavior (Zhang, 2012).

H3: Output factors have a significant impact on Households' intention to switch to producing organic incense.

In the study by Cranfield et al. (2010), four benefit dimensions of organic production are highlighted, including the financial dimension. This financial aspect primarily focuses on improved net returns, premium pricing, diversification opportunities, government support, and cost-related considerations (Cacek & Langner, 1986; Lampking & Padel, 1994; Michelsen et al., 1999). A research undertaken in India indicates that successfully promoting green manufacturing methods to the appropriate target customers can result in a rise in revenue (Jayaraman et al., 2012). Profitability and economics are the two reasons affecting the intention to convert dairy and vegetable producers to organic production (Cranfield et al., 2010).

H4: The more attractive the financial factors, the higher the household intention to switch to producing organic incense.

According to Nga et al. (2021), age, experience of main laborers in vegetable production, and training participation have significant impacts on farmers' decision to adopt safe vegetable production procedures. A study by Hung et al. (2021) showed that the decision to use advanced technologies in coffee production is influenced by four key factors: the farmer's age, educational attainment, years of experience, and institutions (credit, extension services, and information access). In addition, education has a large and statistically significant intra-household spillover influence on households' adoption decisions (Abay Asfaw & Assefa Admassie, 2005).

H5: Control factors are significantly associated with households' intention to switch to producing organic incense.

In the past, there have been many studies on the intentions and behaviors of producers regarding the production of green or environmentally friendly products. These studies have also identified the factors that influence the intentions of producers. In Vietnam, there is some research on developing traditional craft villages. However, these studies have not yet synthesized the factors and there is no specific research on the intention to shift to the production of pure herbal incense by households in traditional incense-making villages. Therefore, the research was carried out by the group of authors. The research model is indicated in Figure 1.

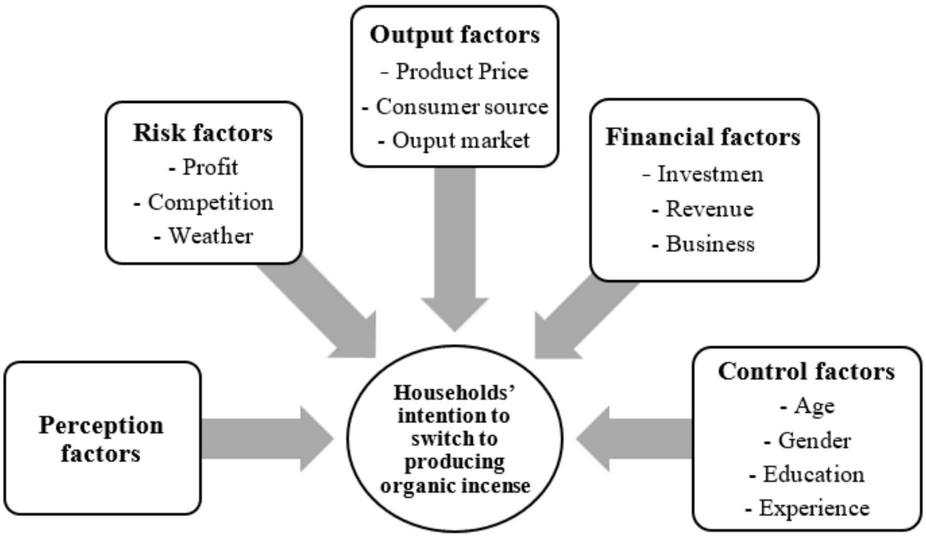

Figure 1: Research model

Source: Compiled by authors

3. Methods

3.1. Data collection methods

We collected secondary data on the incense production situation from the localities that produce incense (at the People's Committees of the communes). For primary data, we conducted direct surveys of incense-producing households in the incense-making village of Quoc Tuan commune, Nam Sach district, Hai Duong, and online surveys of producing households in the craft village of Thuy Xuan ward, Phong Dien district, Thua Thien Hue. The survey sample results include 60 production households in Quoc Tuan Fragrance Village, Hai Duong Province, and 57 production households in Thuy Xuan Fragrance Village, Thua Thien Hue Province. We applied a random sampling method due to the limited number of incense-producing households in the villages mentioned above; therefore, we could not use the commonly applied sampling formulas in this research.

As a child of the homeland, we recognize that maintaining the beauty of the cultural heritage of traditional craft villages is extremely necessary, especially when the younger generation today wishes to leave their hometowns to pursue dreams and modern, new jobs in big cities. With the desire to preserve and promote the cultural tradition of incense making in their hometown, the group of authors conducted research here. At the same time, conducting surveys in the local area is also more convenient and easier for the authors.

In our research, we include 5 groups of independent variables: Perception factors, Risk factors, Output factors, Financial factors, and Control factors. In that, the perception variable is measured using a 5-point Likert scale. These variables are derived from previous studies in the field of environmental protection, green production, sustainable development, and eco-friendly products (Al Mamun et al., 2018; Leonidou et al., 2019; Li et al., 2020; Liu et al., 2023).

Table 1: Variables Summary

Variables' Name	Meaning	Measurement
Export	Household produce incense to export	-
Pagoda	Household produce incense to sell for pagoda	-
Retail	Household produce incense to sell for retail	-
Friend	Households' consumer sources are introduced by their friends	-
Partner	Households' consumer sources are introduced by their Partner	-
Family	Households' consumer sources are from the previous generation	-
Self_Adv	Self-advertising	-
Price_Organic	Price of organic incense	Thousand VND
Price_Tradition	Price of traditional incense	Thousand VND
Risk_Profit	Risks about profit in the production process	-
Risk_Competitor	Risks about competitors in the production process	-
Risk_Market	Risks about market in the production process	-
Risk_Climate	Risks about climate in the production process	-
Enterprise	The type of business of the household is Enterprise	-
Household	The type of business of the household is Household	-
Having a business license registration	The type of business of the household is having a business license registration	-
Cost_Tradition	Cost of traditional incense	Million VND
Cost_Organic	Cost of organic incense	Million VND
Incense_Revenue	Revenue from incense production	Million VND
Invest_Tech	Investment for Technology	Million VND
Invest_Machine	Investment for Machine	Million VND

Variables' Name	Meaning	Measurement
Age	Age of producer	Years
Gender	Gender of producer	-
Education	Education of producer	Years
Experience	The number of years that incense producers have been in the profession up to now.	Years
Envi	Perception of Environment	-
Product	Perception of Product	-
Tech	Perception of Technology	-
Value	Perception of Traditional Craft Village's Value	-
Policy	Perception of Support Policies	-

Source: Compiled by the authors

3.2. Data processing and analysis methods

After collecting the data, Excel 2019 was used for initial synthesis and processing. For further analysis, Stata 17 software was employed to examine the factors influencing households' willingness to produce organic incense in traditional craft villages. Specifically, the study applied a Fractional Regression Model to explore the relationship between the dependent variable - households' intention to produce organic incense and various independent variables, including perception, risk, output, financial, and control factors.

The purpose of the fractional regression model is to examine the relationship between independent and dependent variables, particularly in situations when the dependent variable is expressed as a fraction. In this research, I (Intention) denote the households' intention to switch to producing organic incense. The estimation of the model is described as follows:

$$Ln[I|x] = G\ (b.x)\ (1)$$

Where:

The logistic function is represented by G(.) and has to satisfy the condition 0 <= G(.) <= 1 (Wooldridge, 2010).

x: dependent variables

Based on the research overview, the authors proposed the following model:

$$\mathbf{Ln\ (I|P_i;\ R_i;\ O_i;\ F_i;\ C_i) = G\ (b_1.P_i + b_2.R_i + b_3.O_i + b_4.F_i + b_5.C_i + u_i)}$$

b_i: Coefficients representing the impact of each group of factors (i: the ith observation)

P_i: Perception factors

R_i: Risk factors

O_i: Output factors

F_i: Financial factors

C_i: Control factors

4. Results

In our main regression, we run two models: Model (1) is Fractional regression, and Model (2) is OLS regression.

The impact of all variables is not tremendously different between the models, but there is a slight difference in the statistical significance of the coefficients. Some variables are insignificant in the Fractional model but significant in the OLS model and vice versa.

Table 2: Estimation result of regression models

	Fractional regression (1)		OLS regression (2)	
Incense	Coefficient	Std. err.	Coefficient	Std. err.
Output factors				
Export	-0,150	0,185	-0,027	0,046
Pagoda	-0,509	0,440	-0,080	0,064
Retail	0,109***	0,009	0,025***	0,006
Friend	0,256***	0,008	0,062***	0,016
Partner	0,237***	0,085	0,061***	0,020
Family	-0,060***	0,005	-0,018***	0,005
Self_Adv	-0,158***	0,028	-0,037***	0,002
Price_Organic	0,009***	0,002	0,002***	0,000
Price_Tradition	-0,010***	0,001	-0,002***	0,000
Risk factors				
Risk_Profit	-0,070***	0,005	-0,016	0,011
Risk_Competitor	0,019*	0,011	0,001	0,008
Risk_Market	-0,046	0,052	-0,005***	0,001
Risk_Climate	0,380	0,236	0,078**	0,034
Financial factors				
Business				
Enterprise	-0,010***	0,002	-0,003	0,004
Household	0,190***	0,063	0,049**	0,021
Having a business license registration	0,229**	0,092	0,058**	0,026
Cost_Tradition	0,002	0,003	0,000	0,001
Cost_Organic	0,0000654**	0,000	0,0001102***	0,000
Incense_Revenue	0,001**	0,001	0,000**	0,000
Invest_Tech	0,001	0,001	0,000**	0,000
Invest_Machine	-0,003**	0,001	-0,001***	0,000
Control factors				
Age	-0,028	0,053	-0,003	0,007
Gender	0,026***	0,010	0,002	0,005
Education	-0,031***	0,000	-0,003***	0,001
Experience	0,010***	0,003	0,003**	0,001
Perception factors				
Envi	-0,049	0,229	-0,011	0,053
Product	-0,005	0,135	-0,004	0,025
Tech	-0,080***	0,005	-0,021***	0,002
Value	0,134***	0,009	0,040***	0,006
Policy	-0,213***	0,016	-0,050***	0,006
_cons	0,240	0,940	0,475	0,083
Observation	117		117	
Note: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$				

Source: Compiled by authors

We use regression results from the fractional regression model since the dependent variable is proportional, this model is interpreted and has greater significance than the OLS model. The findings indicate that the desire of households to switch to producing only pure herbal incense is influenced by each of the five categories of influences. Within each group, there are differences in the specific variables and the degree of influence.

The results from Table 2 show that these factors including Retail, Friend, Partner, Price_Organic, Risk_Competitor, Household, Having a business license registration, Cost_Organic, Incense_Revenue, Gender, Experience, Value have positive impacts on the intention of households to produce organic incense while Family, Self_Adv, Price_Tradition, Risk_Profit, Enterprise, Invest_Machine, Education, Tech, and Policy variables have negative impacts; the remaining variables (Export, Pagoda, Risk_Market, Risk_Climate, Cost_Tradition, Invest_Tech, Age, Envi, Product) have no statistical significance.

5. Discussion and Implications

This study has identified five groups of factors that significantly influence households' intention to switch to producing organic incense in traditional craft villages, including Perception factors, Risk factors, Output factors, Financial factors, and Control factors. And the results prove that all the hypotheses put forward are correct. Based on the research results, we suggest solutions for production households as well as local authorities to raise awareness among traditional production households about the benefits and values that herbal incense brings to consumers' spiritual lives, health, and the environment.

First, regarding the group of output factors, the variables Retail, Friend, Partner, and Price_Organic have a positive impact on the intention to switch to producing organic incense among households in traditional craft villages, as they reduce barriers and enhance motivation for the transition to organic incense production. Factors such as effective distribution channels, support from social networks and partners, and reasonable pricing, all contribute to facilitating and encouraging households in traditional craft villages to make this transition. Conversely, the variables Family, Self_Adv, and Price_Tradition have a negative impact on the dependent variable. The available resources left by the previous generation may reduce the motivation to seek new customers, and customer acquisition through advertising may be ineffective without a suitable advertising strategy. Additionally, the higher price of traditional incense compared to that of organic incense may lead households to find it more reasonable to stick with their current products. These factors combined can reduce the appeal and motivation for households to transition to producing organic incense. To optimize efficiency and minimize risks, incense production households should consider diversifying their product distribution channels instead of relying on just a few distribution channels. At the same time, local authorities need to establish appropriate support policies for incense-producing households, especially encouraging the transition from traditional incense production to organic incense. This not only helps improve consumer health but also contributes to environmental protection, creating a more sustainable and efficient production environment.

Secondly, regarding the group of risk factors, Risk_Profit has a negative impact on households' intention to switch to producing organic fragrances, while Risk_Competitor has a positive effect. These results are similar to previous studies (Li et al., 2022; Hu et al., 2022; Li et al., 2020; O'Connor et al., 2006). This can be explained by the fact that traditional incense has been certified by the market and provides stable profits for households. The transition to producing organic incense may raise concerns about the ability to maintain or increase profits compared to current products. However, the production of organic incense could open up opportunities for households to participate in a new market, where there is less competition or where they may have a competitive advantage in terms of quality and sustainability. The supply is dependent on the demand; if the demand for traditional incense is high, they will continue to produce those. The producers believe that they are only willing to switch when buyers understand organic products and switch to using those items. Nowadays, consumers' awareness of green products has increased, and there is a tendency to consume more green products. Therefore, households need to recognize this and produce organic incense to meet the demands of today's eco-conscious consumers. During the production process, households also need to clearly recognize the risks they are facing and implement appropriate preventive and management measures. Besides, local authorities should implement incentive and reward policies for households that produce organic incense because preserving the long-standing cultural identity is not easy, and it has to align with contemporary goals of green and clean production. Additionally, it is necessary to establish insurance funds to protect households against unexpected risks.

Thirdly, among the financial factors, the elements positively influencing households' intention to switch to producing organic incense include Household, Having a business license registration, Cost_Organic, and Incense_Revenue. When households produce on a small scale and have business licenses, they ensure legality and operate legally, which builds trust for both customers and partners. Household scale helps optimize the production costs of organic incense because the owner can closely control the costs of raw materials and the production process, thereby minimizing waste. As a result, revenue from the production of organic incense is on the rise due to effective management and reasonable production costs. On the contrary, Enterprise and Invest_Machine have a negative impact on households' intention to switch to organic incense production because when scaling up production to an enterprise level, producers face increased costs, particularly in input materials and investment in technology. Investing in new machinery and technology necessary for the production of organic incense can significantly increase investment costs, which poses a major challenge in the fiercely competitive environment of the organic incense market. Faced with high costs and significant investment demands, businesses may struggle to maintain profitability and compete effectively, especially when organic incense products are still a new trend and not widely accepted in the market. Therefore, to maximize profits, households should control production costs and seek stable sources of input materials. At the same time, strengthening connections with consumption markets is essential to stabilize output. Besides, households should diversify their products to minimize profit risks and enhance competitiveness through quality and design improvements. At the same time, local authorities also need to encourage households to have business licenses and provide preferential credit packages and financial support for families transitioning to produce organic incense.

Finally, in the group of Perception factors, awareness of value positively impacts the intention to produce organic incense among households, as it not only helps to preserve and develop cultural heritage but also creates new economic, social, and branding opportunities. The combination of traditional techniques with modern products such as organic incense helps protect traditional crafts while meeting the demands of the modern market, thereby promoting the production and development intentions of households. Conversely, awareness of policies and technology has a negative impact on the intention of households in traditional craft villages to produce organic incense. Producing organic incense may require investment in new technology to ensure quality and production efficiency. Households may feel that the investment costs for new technology are too high and challenging, especially if they lack sufficient financial or technical resources. Furthermore, if local authorities do not have incentive policies or financial support to encourage the production of herbal incense, households may perceive that investing in the production of this type of incense poses a greater risk compared to maintaining traditional incense production. Therefore, to encourage households to shift towards producing organic incense, local authorities need to implement financial support policies, connect investment funds with production households, or attract outside investors to help these households alleviate the financial burden when transitioning to new production technologies. In addition, households can participate in scientific workshops/conferences on new technologies applied in production to learn more and implement them in their local areas.

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Energy Efficiency and Total Factor Productivity: Evidence from Vietnam Processing and Manufacturing Enterprise

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Abstract

The processing and manufacturing sector constitutes a cornerstone of Vietnam's economic landscape. Consequently, its development and enhancement are paramount. However, certain limitations, such as technological deficiencies, infrastructural inadequacies, and labor skill constraints, within this sector hinder its labor productivity, particularly in the realm of energy consumption. This research delves into the correlation between total factor productivity (TFP) and energy efficiency (EE) by analysing enterprise-level data spanning from 2011 to 2022, employing the Generalized Method of Moments (GMM) methodology. Our findings elucidate a negative relationship between the energy consumption-to-value-added ratio and TFP, suggesting that inefficient energy utilization can adversely impact TFP growth. Conversely, improvements in EE can positively influence TFP. To address these challenges, we propose several solutions, including government support for technological innovation and the encouragement of manufacturers to adopt practical energy management standards.

Keywords: *Energy efficiency (EE), processing and manufacturing industry, generalized method of moments (GMM), total factor productivity (TFP)*

1. Introduction

Energy efficiency (EE) has emerged as a pivotal focus of public policy in developed nations, addressing both environmental and economic concerns. EE, as defined by the U.S. Department of Energy, involves optimizing energy use to achieve the same outcomes. Beyond environmental benefits, EE investments offer economic and social advantages. They not only reduce emissions but also enhance industrial competitiveness, lower costs, and create jobs. For instance, (Chan, 2007) highlights how improvements in EE within Taiwan's energy-intensive industries boost competitiveness while cutting greenhouse gas emissions. These improved competitive opportunities and production expansion are considered positive economic factors contributing to job creation (Celani de Macedo A, 2020).

Historically, businesses often perceived investments in energy efficiency (EE) and conservation as detrimental to productivity. This notion stemmed from the belief that such initiatives would divert resources from core production activities. However, technological advancements and evolving business strategies have challenged this paradigm. Michael Porter posits that environmental regulations can actually enhance competitiveness (Porter, 1991). (Van der Linde C, 1995) concurs, arguing that well-designed regulations can stimulate innovation, leading to reduced production costs. These innovations optimize resource utilization, including capital, raw materials, labor, and energy, often yielding efficiency gains that offset initial investment costs. This suggests that EE can be a strategic asset rather than a cost burden. As more businesses recognize this potential, the traditional view of EE as a trade-off with productivity is giving way to a more nuanced understanding of their synergistic relationship.

Empirically, numerous studies have explored the relationship between EE and firm productivity, demonstrating a positive correlation. Most of these literature calculated EE as the reciprocal of energy intensity indicators, including (Sahu S K, 2011), (Cantore, 2016), (Montalbano P, 2019), (Haider S, 2020), (Zhang D, 2020), (Caragliu, 2021), (Santos J, 2021), (Macharia K K, 2022). Moreover, other researchers have utilized other methods of calculating EE and reported positive associations. (Worrell E, 2003) employed a bottom-up conservation supply curve (CSC) approach; (Jiang L, 2021) and (Hu X, 2016) calculated EE by comparing the optimal (predicted) energy input to the actual energy input used by firms, (Montalbano P, 2019) utilized the ratio of energy input costs to total input costs, (Celani de Macedo A, 2020) employed an input-output (IO) model, further supporting the positive impact of EE on TFP.

While the prevailing evidence suggests a positive correlation between EE and firm productivity, a few studies have reported inconclusive or negative results. For example, (Pons M, 2013) observed a positive association with environmental performance but no significant impact on economic performance. Similarly, (Jiang L, 2021) identified a negative correlation between EE and productivity in China's chemical industry, highlighting the potential sector-specific nature of EE benefits.

A growing body of research has elucidated the complex relationship between EE and total factor productivity (TFP) across developed and developing nations. While the advantages of EE are well-established in developed economies, developing nations often grapple with a trade-off: relying heavily on increasing energy production and consumption to drive economic growth (Cantore, 2016). This raises a critical question for developing nations: is it essential to prioritize EE when resources could be directly allocated to enhance economic performance?

In Vietnam, the processing and manufacturing industry plays a crucial role in the economy, contributing 14.9% of GDP between 2011 and 2020. This sector has exhibited robust growth, expanding at a rate of 10.44%. Moreover, it is the country's largest energy consumer, accounting for 47.5% of total energy consumption in 2019. As industrial energy consumption continues to rise, there is significant potential for implementing EE measures to reduce costs and improve productivity.

Given Vietnam's status as a developing nation and the energy-intensive nature of its processing and manufacturing sector, understanding the relationship between EE and TFP is essential. Despite extensive international research affirming a positive association between these two variables, empirical evidence for this correlation within the Vietnamese context remains limited. This study seeks to bridge this gap by examining the link between EE and TFP in Vietnam's processing and manufacturing sector. It aims to identify practical solutions that enable Vietnamese businesses to achieve their production objectives while minimizing energy consumption, fostering both economic growth and environmental sustainability.

Following this introduction, the research is structured into three primary sections: methodology, results and discussion, and conclusions with policy recommendations.

2. Methodology

2.1. Model specification

A firm i in industry j produces according to a Cobb-Douglas production function of the following form:

$$Y_{it}^{j} = A_{it}^{j} K_{it}^{j,\beta_k} L_{it}^{j,\beta_l} M_{it}^{j,\beta_m} \ (1)$$

Here, Y_{it}^{j} , K_{it}^{j}, L_{it}^{j} and M_{it}^{j} represent the output, labor input, capita and raw material (intermediate input) respectively. α is a constant. The coefficients for labor, raw materials, and capital are β_l, β_m, and β_k, respectively. i, j, and t respectively represent firm i, industry j, and year t.

After applying the logarithmic transformation to both sides of equation (1) and the error term is split into two components ω_{it} and ε_{it}^{j} (Levinsohn & Petrin, 2003), the following form of equation (1) can be obtained:

$$y_{it}^{j} = \alpha + \beta_l l_{it}^{j} + \beta_m m_{it}^{j} + \beta_k k_{it}^{j} + \omega_{it} + \varepsilon_{it}^{j} \ (2)$$

The productivity component ω_{it} is an unobserved error term, and the component ε_{it}^{j} is an i.i.d that has no impact on the decisions of the factory. It represents unpredictable shocks with a mean of 0 for realized productivity after input is selected.

Model (2) may face endogeneity, as TFP increases can raise output and input factors, with unobservable factors also affecting TFP. Input choices may take time to impact TFP. (Loecker, Product Differentiation, Multiproduct Firms, and Estimating the Impact of Trade Liberalization on Productivity., 2011) showed that the number of selected inputs is correlated with unobserved productivity shocks leading to simultaneity bias.

(Levinsohn & Petrin, 2003) is an improvement on the procedure developed by (Olley & Pakes, 1996), which proposed using investment as a proxy for unobserved productivity shocks. This procedure requires the investment variable to be non-negative and indispensable.

Thus, based on model (2), TFP can be calculated as follows:
$TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it}$ (3)
The results of estimating the TFP model with data from the enterprise survey in the period 2011-2021 are as follows:

According to (Cantore, 2016); (Montalbano P, 2019) and (Macharia K K, 2022), TFP is modelled as a function of EE as follows:

$TFP_{it} = f(EE_{it})$ (4)

In this model, EE represents the EE index of firm i in year t.

In reality, many factors influence a firm's TFP: (1) The positive impact of R&D on TFP (Romer, 1986); (Castany, 2005); (Chen & Dahlman, 2004); (Calligaris, 2016); (Crass, 2014). (2) The capital-to-labor ratio, or capital intensity advances production techniques that bolster TFP (Rath, 2018). (3) The age of the firm can affect TFP (Arrow, 1962); (Stiroh, 2001); (Marshall, 1890); (Hannan & Freeman, 1984); (Majumdar, 1997); (Fernandes, 2008); (Coad, 2013). (4) Foreign ownership significantly affects a firm's TFP (Harris & Robinson, 2002); (Harris R. , 2003); (Zhou, 2002). (5) Firmsize can have a positive impact on TFP (Satpathy L, 2017) and (Şeker, 2018). (6) HHI plays a crucial role in TFP growth (Guidelines, 2010); (Liston-Heyes C. , 2004); (Haskel, 1991) and (Kahyarara, 2013)). (7) The impact of firms participating in import and export on TFP (Tybout, 1998); (Bernard, 1995); (Grossman, 1991); (Loecker, Do exports generate higher productivity? Evidence from Slovenia, 2007); (Bloch, 2007); (Ortega, 2013). (8) Inflationary pressures can impact TFP at both the firm and industry levels (Serhan Cevik, 2024). (9) Good management positively impacts a firm's TFP (Ichniowski, 1997); (Lazear, 2000); (Bloom, 2007). (10) Other factors, such as financial constraints, capital structure, and wages, also play a crucial role in TFP growth (Aghion, 2007); (Fazzari, 1988); (Commission, 2014); (Jensen, 1986); (Nickell. S., 1999); (Köke, 2001); and (Gehringer, 2013).

So, combining equations (3) and (4), the model that represents the impact of EE on TFP is as follows:

$lnTFP_{it} = \beta_0 + \beta_{EE} lnEE_{it} + \beta_C C_{it} + \beta_W W_i + \mu_{it}$ (5)

The prefix ln represents the logarithmic form of the variables.

C_{it} refers to time-varying factors, meaning these are variables that can change over time for a given firm. Examples of such variables include capital intensity, firm age, size, the Herfindahl-Hirschman Index, import/export activity, and inflation. These dynamic factors can fluctuate over time, affecting a firm's productivity.

W_i refers to time-invariant factors, which are characteristics of firms that do not change over time. These include factors like the firm's location, industry sector, and initial technology level. These static factors remain constant over time, serving as a baseline or fixed effect in the analysis.

β_0 and μ_{it} are the intercept and error terms of the model. β_{EE}, β_C, and β_W are the coefficients of EE, the factors that show time-varying and time-invariant changes.

According to Cantore et al. (2016), the estimation of the model (5) maybe biased is the endogeneity problem, which is affected by unobserved factors that have been omitted and reverse causality meaning the causal relationship between variables in the model. (Macharia K K, 2022) argue that omitted firm characteristics, like management capability, can influence both the adoption of energy-saving technology and TFP. Regarding reverse causality, firms with high EE may have higher TFP either because high EE boosts TFP, or firms with higher TFP use energy more efficiently. Therefore, to address this issue, (Haider S, 2020), (Macharia K K, 2022) added lagged dependent variables to the model. Thus, the model (5) is rewritten as follows:

$$lnTFP_{it} = \beta_0 + \beta_P lnTFP_{it-1} + \beta_{EE} lnEE_{it} + \beta_C C_{it} + \beta_W W_i + \mu_{it} \quad (6)$$

TFP_{it-1} is the TFP of firm i with lag 1 period.

The coefficient β_P represents the coefficient of latency of TFP that affects TFP in the current period. (Macharia K K, 2022) explain that a lagged model reduces the response effect from TFP to EE. This means that decisions to improve technology for EE made in previous stages are based on the operational efficiency of the company.

2.2. Date source

This paper utilizes the annual enterprise survey data conducted by the General Statistics Office from 2011 to 2022.

Enterprise-type classification is based on the criteria of Enterprise Law No. 60/2005/QH11 dated November 29, 2005.

Enterprise scale classification is based on Decree No. 56/2009/NĐ-CP and Decree No. 39/2018/NĐ-CP. Following these decrees, the study categorizes enterprise scale based on the number of employees into four main types: micro-enterprise (10 employees or less); small enterprise (Over 10 to 200 employees); medium-sized enterprise (Over 200 to 300 employees); large enterprise (Over 300 employees).

Regarding the industry classification, the study adopts the Vietnam Economic Industry System (VSIC 2018) as defined in Decision No. 27/2018/QĐ-TTg dated July 6, 2018. However, the research team has aggregated industries within the processing and manufacturing sector into the following industry groups:

Table 1: Combined industry groups in the processing and manufacturing industry

Code according to VSIC 2018	Type of Manufacturing Industry	According to the aggregated industry groups
10	Manufacture of food products	
11	Manufacture of beverages	
12	Manufacture of tobacco products	Group 1
13	Manufacture of textiles	
14	Manufacture of apparel	
15	Manufacture of leather and related products	Group 2
16	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	
17	Manufacture of paper and paper products	
18	Printing and reproduction of recorded media	Group 3
19	Manufacture of coke and refined petroleum products	
20	Manufacture of chemicals and chemical products	
21	Manufacture of pharmaceuticals, medicinal chemicals, and botanical products	
22	Manufacture of rubber and plastic products	Group 4
23	Manufacture of other non-metallic mineral products	
24	Manufacture of basic metals	
25	Manufacture of fabricated metal products (except machinery and equipment)	Group 5

Code according to VSIC 2018	Type of Manufacturing Industry	According to the aggregated industry groups
26	Manufacture of electronic, computer, and optical products	
27	Manufacture of electrical equipment	Group 6
28	Manufacture of machinery and equipment n.e.c	
29	Manufacture of motor vehicles; trailers and semi-trailers	
30	Manufacture of other transport equipment	
31	Manufacture of furniture	
32	Other manufacturing	
33	Repair and installation of machinery and equipment	
35	Electricity, gas, steam, and air conditioning supply	Group 7

Source: Authors

The economic regions are defined according to the conventions of the General Statistics Office, comprising six regions.

2.3. Calculation of variables in the model

a) Calculation of TFP

TFP is calculated using Stata software based on the algorithm proposed by (Rovigatti & Mollisi). Accordingly, TFP is calculated from equation (3) using the semi-parametric estimation method proposed by (Levinson-Petrin, 2003), based on the approach suggested in the (Olley & Pakes, 1996).

b) Calculation of energy use efficiency

Energy intensity has been widely recognized as a suitable metric for evaluating EE due to its simplicity and practical application in policy development and assessment (Fan, 2017). Several studies, including those by (Subrahmanya, 2006), (Cantore, 2016), (Montalbano P, 2019), (Haider S, 2020), and (Macharia K K, 2022) have employed the energy intensity index to assess EE. This index is calculated as the ratio of energy input to output, with lower values indicating higher efficiency. In line with this approach, this study computes energy utilization efficiency using the following formula:

$$EE_{it} = \frac{E_{it}}{VA_{it}} \quad (7)$$

E represents the energy usage index of enterprise i in year t, and VA denotes the value added of enterprise i in year t.

c) Other variables in the model

Capital refers to fixed assets (Castany, 2005).

Capital intensity, the capital-to-labor ratio, indicates the level of capital used in production. High capital intensity often correlates with modern production techniques and increased productivity (Rath, 2018).

As per (Kreuser & Newman, 2018), (Harris & Moffat, 2015), (Satpathy L, 2017), (Fernandes, 2008), (Rath, 2018), (Şeker, 2018), and (Macharia K K, 2022), the control variables encompass firm age, firm size, foreign ownership, export status, capital intensity, R&D, and top management experience. Older firms may benefit from learning-by-doing (Kreuser & Newman, 2018) but could suffer from outdated equipment (Harris & Moffat, 2015). Experienced managers are expected to improve productivity (Fernandes, 2008).

Foreign firms can enhance total factor productivity by introducing superior technology and advanced skills (Harris & Moffat, 2015). The study uses the foreign share of total capital (FS) as a proxy for their presence.

Following previous studies, larger firms often have higher TFP due to better market access and financial resources (Satpathy L, 2017), while smaller firms might be more productive due to their adaptability and streamlined management (Şeker, 2018).

Market concentration, measured by the Herfindahl-Hirschman Index (HHI), has been employed extensively in competition law, antitrust analysis (Guidelines, 2010), and technology management (Liston-Heyes P. , 2004); is linked to technological innovation. (Haskel, 1991) and (Kahyarara, 2013) provide supporting evidence from the UK and developing countries, respectively.

A dummy variable is used to classify firms as domestic or international. Firms involved in international trade are coded as 1, while domestic firms are coded as 0. This variable is expected to capture the potential productivity effects associated with international trade. Firms engaged in import-export operations often exhibit higher productivity levels. (Fernandes, 2008) posits that exporting firms often improve their technology to compete in foreign markets while (Wagner, 2005) highlights that competition between domestic and foreign exporters can lead to better technology and productivity. A substantial body of literature supports this assertion, including studies by (Bernard, 1995), (Tybout, 1998), (Liu, 1999), (Aw & Hwang, 1995), Tsou et al. (2002), (Biesebroeck, 2003), (Fariñas, 2007), (Greenaway, 2005), (Pär, 2004), (Girma, 2004), and (Voulgaris, 2005).

Inflationary pressures can impact TFP at both the firm and industry levels, as demonstrated by (Serhan Cevik, 2024). This study employs the inflation rate of total domestic output as a proxy for overall economic inflation.

Table 2: Description of the variables

Variable		Calculation method	Data collection source
Total Factor Productivity	TFP	Calculated from the semi-parametric model	From the Enterprise Survey, GSO
Capital/labor ratio	R	Capital/labor	From the Enterprise Survey, GSO
Firm age	Firmage	Number of years in production and business operation	From the Enterprise Survey, GSO
FDI firm dummy variable	D_FDI	Equal to 1 for FDI enterprises and otherwise equal to 0.	From the Enterprise Survey, GSO
Firm size dummy variable	Firmsize	Based on Decree No. 56/2009/ND-CP and Decree No. 39/2018/ND-CP	From the Enterprise Survey, GSO
Industrial concentration level	HHI	Herfindahl - Hirschman Index	From Enterprise Survey, GSO
Firms participating in import and export	XK	equal to 1 for firms participating in export/import activities and otherwise equal to 0.	From the Enterprise Survey, GSO
Consumer Price Index	CPI	Logarithmic form of gross domestic product at current prices/gross domestic product at comparative prices	GSO

Source: Authors

2.4. Description

Table 3: Descriptive Statistics Results

Variable	Mean	Std. dev.	Min	Max
Loga TFP	0.777193	1.303426	-7.81296	17.49044
EE	2.665789	1.247426	44.74193	1.988712
Loga R	3.860694	5.143853	-21.3303	14.98868
Firmage	4.623295	6.420493	1	76
Firmsize	1.436237	0.675864	1	4
HHI	0.051118	0.168407	0.001539	0.998571
XK	0.051073	0.220146	0	1
CPI	0.390325	0.16429	-0.39644	1.239631

Source: Authors

2.5. Estimation method

Model (6) may have heteroscedasticity, meaning the error variance is not constant across all observations. In this model, factors like capital intensity, firm size, or inflation (factors within CitC_{it}Cit can cause various levels of fluctuation in firm TFP.

Additionally, model (6) may have endogeneity, meaning one or more independent variables are correlated with the error term. This can happen if factors like EE are influenced by unobserved factors within μit\mu_{it}μit, or if a lagged TFP variable is used, particularly if the previous period's TFP is affected by unobserved factors or errors.

Ordinary Least Squares (OLS) estimates for fixed effects and random effects panel data models can manage unobserved firm heterogeneity but not reverse causality (Macharia K K, 2022). (Hansen, 1982) proposed the Generalized Method of Moments (GMM), a method that can handle heteroscedasticity. It adjusts for inconsistencies in the error variance using weighted calculations.

(Arellano & Bond, 1991) used GMM for dynamic panel models. They used lagged values values of the covariance as instruments for endogenous variables as instruments and tested their validity with the Sargan-Hansen test. Additionally, 2SLS can be used instead of GMM. To determine the appropriate estimation method for the current data, the (Pagan, 1983) test for heteroscedasticity in ranking error is applied. GMM is more efficient with heteroscedasticity, while 2SLS is better without it.

The key advantage of GMM is that it can manage both endogeneity and heteroscedasticity. It can also work with complex panel data and many instrumental variables, making it useful for economic studies.

3. Results and Discussion

In this section, the research team presents the results obtained from analyzing the impact of EE on TFP through the findings obtained from the estimating model (6) using the Generalized Method of Moments (GMM) estimation approach. The effects of various factors on TFP are examined through the estimation of firms' productivity function discussed earlier, which is a dynamic quantitative economic model where the lagged TFP variable is included on the right-hand side of the model. This assumes that the domestic productivity of firms depends not only on external factors but also on firms' TFP from previous years. To address this issue, the GMM estimation method based on the dynamic model by Arellano and Bond (1991) is applied.

3.1. Estimate TFP overall and by region

The estimation results provide key insights into the relationship between energy efficiency (EE), total factor productivity (TFP), and other important factors. In most regions, the lagged TFP coefficient is positive and statistically significant, indicating that past TFP growth positively affects current growth. This highlights the need for both the government and businesses to prioritize sustained TFP growth over time. However, in Region 2 and 4, the lagged TFP is not significant, suggesting possible regional differences.

Across nearly all models, EE has a negative and significant impact on TFP, meaning that higher energy use relative to value added (VA) tends to hinder productivity growth. This finding is consistent with previous studies like those by (Worrell E, 2003); (Sahu S K, 2011); (Cantore, 2016); (Hu X, 2016); (Montalbano P, 2019); (Haider S, 2020); (Celani de Macedo A, 2020); (Zhang D, 2020); (Jiang L, 2021) (for firms in the textile industry); (Santos J, 2021); (Caragliu, 2021); and (Macharia K K, 2022).

Table 4: Estimation results overall and by regions

VARIABLES	(1) Total	(2) Region 1	(3) Region 2	(4) Region 3	(5) Region 4	(6) Region 5	(7) Region 6
L.tfp	0.0772***	0.1205***	0.0295	0.0636***	0.0232	0.0226***	0.0560***
	(0.0042)	(0.0085)	(0.0215)	(0.0113)	(0.0191)	(0.0053)	(0.0136)
EE	-0.0006***	-0.2120***	-0.0062***	-0.0047***	-0.00169***	-0.0005***	-0.0003***
	(0.0001)	(0.0363)	(0.0002)	(0.0007)	(0.0002)	(0.0001)	(0.0000)
lr	0.0118***	0.0109***	0.0121***	0.0224***	0.0284***	0.0140***	0.0048
	(0.0006)	(0.0010)	(0.0029)	(0.0017)	(0.0059)	(0.0010)	(0.0031)
Firmage	0.0674***	0.0211*	0.1010***	0.1313***	0.1742***	0.0927***	0.1274***
	(0.0058)	(0.0110)	(0.0268)	(0.0161)	(0.0438)	(0.0084)	(0.0203)
D_fdi	0.1938***	0.2465***	0.1218**	0.0998	0.3862	0.0846*	0.0759
	(0.0203)	(0.0264)	(0.0606)	(0.0754)	(0.2822)	(0.0500)	(0.2186)
Firmsize	-0.0746***	-0.0393*	0.0025	-0.1224***	0.0277	-0.1075***	-0.2099***
	(0.0132)	(0.0223)	(0.0508)	(0.0354)	(0.1170)	(0.0204)	(0.0479)
hhi	-0.1972***	-0.1141***	-0.1575*	-0.0924	-0.0242	-0.2342***	-0.3673***
	(0.0204)	(0.0313)	(0.0907)	(0.0582)	(0.1601)	(0.0298)	(0.0969)
XK	0.0443*	0.0181	0.2270**	-0.0595	0.2252	0.0556*	0.1318
	(0.0235)	(0.0473)	(0.0988)	(0.0718)	(0.1652)	(0.0307)	(0.0939)
lcpi	-0.2933***	2.6268***	0.1558	-1.7448***	-2.3986***	-8.8465***	-1.6946***
	(0.0829)	(0.1169)	(0.3500)	(0.1929)	(0.3629)	(0.2960)	(0.2171)
Constant	0.3790***	-0.8177***	-0.0128	0.7988***	1.1538***	3.3048***	0.7536***
	(0.0413)	(0.0682)	(0.1867)	(0.1200)	(0.3692)	(0.0959)	(0.1433)
Observations	182,391	57,355	8,910	22,387	3,009	77,451	13,279
Number of ID	95,617	30,219	4,846	11,093	1,595	40,124	7,740

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors

The capital-to-labor ratio is consistently positive and significant, showing that firms with higher capital intensity and advanced manufacturing techniques tend to achieve better productivity.

Firm age also has a positive impact on TFP, suggesting that more experienced firms benefit from better management practices, in line with research by Jensen et al. (2001) and (Fernandes, 2008). This implies that firms with a more extended operating history have more experience in management, which helps enhance TFP.

The FDI dummy variable shows a positive effect in the overall sample and in Regions 1, 2, and 5. However, this contrasts with some previous studies, possibly because foreign firms in Vietnam may be focusing more on low labor costs than on improving productivity.

Firm size is significant in several regions, indicating that larger firms often have a stronger influence on TFP, while the Herfindahl-Hirschman Index (HHI) suggests that higher industry concentration reduces opportunities for productivity gains.

Import and export activities positively influence TFP in Regions 2 and 5, underscoring the benefits of international trade in these areas.

Lastly, inflation has a negative and significant effect on TFP, signaling that high inflation hampers labor productivity growth.

3.2. Estimate TFP by several combined industry groups

The model results show that lagged TFP generally has a positive and significant impact across most industry groups, indicating that past TFP growth boosts current productivity. However, in industry group 6 (electronics and electrical equipment), this effect is not significant, likely due to the rapid pace of technological innovation in this sector, which diminishes the influence of past productivity gains.

The EE coefficient is negative and significant in most models, meaning higher energy use relative to value added (VA) reduces TFP. In contrast, in energy-intensive industries like dyeing and natural material manufacturing (group 2), EE has less impact on productivity due to inherently high energy consumption.

Variables such as capital/labor ratio, firm age positively affect TFP in most groups, while FDI dummy variables, Firmsize, HHI, inflation variables show negative impacts in some. These findings are consistent with the overall results for the regional sample.

The export variable is generally insignificant, except for group 1, where it has a positive effect, underscoring the need to consider industry-specific factors when evaluating export influences on TFP.

Table 5: Estimation results by industry groups

VARIABLE	(1) Group 1	(2) Group 2	(3) Group 3	(4) Group 4	(5) Group 5	(6) Group 6	(7) Group 7
L.tfp	0.0970***	0.0741***	0.0824***	0.0747***	0.0773***	0.0228	0.0850***
	(0.0118)	(0.0103)	(0.0104)	(0.0094)	(0.0080)	(0.0286)	(0.0119)
EE	-0.0362***	-0.1173	-0.0139***	-0.1263***	-0.0006***	-1.3797***	-0.0006***
	(0.0129)	(0.0866)	(0.0035)	(0.0408)	(0.0001)	(0.1999)	(0.0001)
lr	0.0171***	0.0024	0.0088***	0.0140***	0.0193***	0.0073**	0.0107***
	(0.0023)	(0.0017)	(0.0019)	(0.0016)	(0.0011)	(0.0037)	(0.0015)
Firmage	0.0656***	0.0558***	0.0938***	0.0880***	0.0612***	0.0375	0.0545***
	(0.0177)	(0.0141)	(0.0126)	(0.0152)	(0.0117)	(0.0423)	(0.0152)
D_fdi	0.2417*	0.0432	0.3280***	0.3659***	0.2438***	0.2827***	0.2100***
	(0.1355)	(0.0372)	(0.0897)	(0.0487)	(0.0484)	(0.0584)	(0.0531)
Firmsize	-0.1289***	-0.1269***	-0.0803***	-0.0017	-0.0796***	-0.0804*	-0.0717**
	(0.0432)	(0.0304)	(0.0310)	(0.0373)	(0.0266)	(0.0454)	(0.0332)
hhi	-6.1910***	-0.3591***	-0.0449	-0.5666***	0.1500	-0.9160**	-0.6014***
	(0.6534)	(0.0419)	(0.0380)	(0.1506)	(0.1101)	(0.3844)	(0.0451)
XK	0.2065***	0.0371	-0.0055	0.0192	0.0380	-0.0311	0.0040
	(0.0702)	(0.0467)	(0.0643)	(0.0619)	(0.0595)	(0.1084)	(0.0520)
lcpi	-0.1701	-0.4902*	0.6417***	-0.6698**	-0.6570***	0.2218	-0.5442**
	(0.2083)	(0.2530)	(0.1804)	(0.2735)	(0.1541)	(0.6198)	(0.2149)
Constant	0.3472***	0.6579***	-0.2097**	0.3461***	0.5995***	0.7893***	0.6155***
	(0.1273)	(0.1137)	(0.0929)	(0.1232)	(0.0791)	(0.2647)	(0.1050)
Observations	19,923	27,197	32,102	21,677	48,869	3,504	29,119
Number of ID	10,552	14,698	16,754	11,630	25,576	2,135	16,636

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors

4. Conclusions and Implications

The processing and manufacturing industry is vital to Vietnam's socio-economic development. Nevertheless, energy consumption within this sector is significant, and solutions are needed to enhance energy efficiency.

This study thoroughly examines the impact of EE on the TFP of firms within Vietnam's processing and manufacturing industry. The findings reveal a positive and significant relationship between improvements in EE and enhanced TFP, underscoring the importance of energy conservation measures in driving productivity growth. The analysis also identifies other critical determinants of TFP, including capital intensity, firm age, FDI, engagement in export-import activities, and macroeconomic stability.

In particular, firms that have adopted energy-efficient practices tend to demonstrate higher productivity levels, indicating that investments in energy-saving technologies yield substantial returns. The study also highlights the role of external factors, such as macroeconomic conditions and FDI, in shaping firm-level productivity, suggesting that both internal firm strategies and external economic environments are critical to enhancing TFP.

Based on the results, it is evident that to enhance a firm's TFP, solutions to promote EE within enterprises are necessary. The government should implement policies encouraging firms to adopt energy-efficient technologies and practices. Incentives such as tax breaks, subsidies, or low-interest loans for investments in energy-saving equipment can motivate firms to prioritize EE, thereby enhancing their productivity. Firms should invest in advanced technology, adopt energy management standards, enhance management capacity, optimize production processes, participate in government support programs, and build a culture of EE to improve TFP.

Additionally, the model's results also indicate the positive impact of variables such as FDI and XK (Export & Import) and the negative impact of CPI, suggesting that to enhance TFP, it is essential to implement policies that encourage export-import activities, strategically attract foreign direct investment (FDI), and maintain macroeconomic stability. Export-oriented firms often achieve higher productivity by accessing international markets and facing competition, so reducing trade barriers and improving logistics infrastructure can significantly boost their performance. Additionally, attracting FDI into sectors with high productivity potential brings valuable capital, advanced technology, and management expertise, which are crucial for growth. Finally, maintaining a stable macroeconomic environment fosters business confidence and encourages long-term investments in productivity-enhancing measures. To achieve this, the government should focus on controlling inflation, stabilizing the currency, and maintaining balanced fiscal policies.

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Appendix

1) Economic region

Region 1. Northern midland and mountainous region comprise 14 provinces (the number before the province name is its code according to the List of Administrative Units): 02. Ha Giang; 04. Cao Bang; 06. Bac Kan; 08. Tuyen Quang; 10. Lao Cai; 11. Dien Bien; 12. Lai Chau; 14. Son La; 15. Yen Bai; 17. Hoa Binh; 19. Thai Nguyen; 20. Lang Son; 24. Bac Giang; 25. Phu Tho

Region 2. Red River Delta includes 11 provinces: 01. Hanoi; 22. Quang Ninh; 26. Vinh Phuc; 27. Bac Ninh; 30. Hai Duong; 31. Hai Phong; 33. Hung Yen; 34. Thai Binh; 35. Ha Nam; 36. Nam Dinh; 37. Ninh Binh

Region 3. North Central and Central Coast: includes 14 provinces: 38 - Thanh Hoa; 40. Nghe An; 42. Ha Tinh; 44. Quang Binh; 45. Quang Tri; 46. Thua Thien Hue; 48. Da Nang; 49. Quang Nam; 51. Quang Ngai; 52. Binh Dinh; 54. Phu Yen; 56. Khanh Hoa; 58. Ninh Thuan; 60. Binh Thuan.

Region 4. Central Highlands includes 5 provinces: 62. Kon Tum; 64. Gia Lai; 66. Dak Lak; 67. Dak Nong; 68. Lam Dong.

Region 5. Southeast includes 6 provinces: 70. Binh Phuoc; 72. Tay Ninh; 74. Binh Duong; 75. Dong Nai; 77. Ba Ria. Vung Tau; 79. Ho Chi Minh City.

Region 6. Mekong Delta includes 13 provinces: 80. Long An; 82. Tien Giang; 83. Ben Tre; 84. Tra Vinh; 86. Vinh Long; 87. Dong Thap; 89. An Giang; 91. Kien Giang; 92. Can Tho; 93. Hau Giang; 94. Soc Trang; 95. Bac Lieu; 96. Ca Mau.

2) Methods of processing enterprise survey data

This study utilizes data from the General Statistics Office's annual Business Survey. This large- - business survey covers all foreign direct investment (FDI) enterprises, state-owned enterprises, and a representative sample (with extrapolation) of non-state enterprises.

In this study, we selected a research sample that includes all enterprises operating in the economy during the period from 2011 to 2022.

In this regard, we handled identifier variables and statistical errors as follows:

To construct a unified unbalanced panel dataset for the period 2010-2018, we processed and generated a unique enterprise identifier (ID) based on information from three variables: province code, tax code, and enterprise establishment code for the entire period.

- Remove observations with missing or duplicate identifier codes.
- Remove observations with missing business type or industry information.
- Remove missing observations or zero values of indicators on the number of employees or fixed assets (businesses that are not yet in operation).
- Industry Code Handling: The research period spans from 2010 to 2018, during which two different industry classification systems were used: (VSIC 2007: Applicable for the period 2010-2017 and VSIC 2018: Applicable for the year 2018); based on the corresponding industry code conversion table, the business's industry code is unified into the VSIC 2018 system (4-digit industry code). The 8 key industry and trade sectors identified by the Ministry of Industry and Trade (MIT) were extracted from the dataset using the industry code conversion table provided by MIT.
- Remove enterprises with negative revenue and missing data.

Drivers Influencing the Adoption Intention towards Solar Photovoltaic (PV) Technology in Vietnamese Households: A Circular Economy Perspective

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Abstract

In this study, the Theory of Reasoned Action (TRA) was employed to explore and forecast the adoption of solar photovoltaic (PV) by Vietnamese households. The investigation focused on various determinants (Perceived risk, perceived benefit, government incentive policies, environmental knowledge, environmental concern, attitudes, and subjective norms) affecting the intention to adopt solar PV in Vietnam, based on a survey of 268 household representatives from urban areas in Northern Vietnam. Participants responded to questionnaires rated on a 5-point Likert scale. The collected data were analyzed using Cronbach's Alpha, Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). The SEM analysis supported the existence of both negative and positive relationships within the model. Consequently, the study provides critical recommendations aimed at significantly boosting the adoption of solar PV technology in Vietnam, addressing key barriers and leveraging opportunities for accelerated growth.

Keywords: *Circular economy, solar PV, Vietnamese households*

1. Introduction

Global population growth and economic development have increased energy consumption. Energy is vital for a country's growth, but many economies still rely mainly on fossil fuels despite technological advances (Hasheem et al., 2022). Reaching "net-zero" is a global priority, and individuals must be encouraged to adopt cleaner technologies to reduce their carbon footprint (Alsulami et al., 2024). Clean energy funds and mandatory green power options have proven to positively impact renewable energy adoption. Many countries have introduced various policies aimed at expanding the use of non-hydro renewable energy in their electric power sectors, seeking to increase the deployment of cleaner energy sources like solar, wind, and biomass (Shrimali & Kniefel, 2011). During the summer months of 2024, electricity consumption in Vietnam has reached a record high of over 1 billion kWh, indicating a growing demand for electricity, especially during hot weather conditions. This underscores the necessity of implementing effective demand management measures and energy-saving practices to ensure a stable and sustainable power supply (Tuan, 2024). Developing renewable energy to address electricity shortages is becoming a top priority. Experts and business leaders in the renewable energy sector consider Vietnam a promising market for distributed solar energy investment. In line with its renewable energy goals, Vietnam has set ambitious targets for rooftop solar energy, aiming for 80% of factories and 20% of residential and office buildings to adopt rooftop solar by 2050, primarily for on-site consumption instead of feeding surplus power back into the grid (Hung, 2023).

Understanding the drivers influencing the adoption intention towards solar photovoltaic (PV) technology in Vietnamese households, from a circular economy perspective, is vital for informing policy decisions and investment strategies. This research aims to identify and analyze these drivers, providing insights that can help accelerate the transition to renewable energy and support Vietnam's sustainability goals.

A number of studies have investigated the factors influencing the adoption of green energy sources and the complex interplay between the circular economy and renewable energy, particularly solar power (Van Opstal & Smeets, 2022; Opstal & Smeets, 2023; Milousi & Souliotis, 2023; Maqbool et al., 2023; Goh et al., 2024). These studies have underscored the importance of perceived risks and benefits in the residential uptake of solar energy and other forms of power (Tanveer et al., 2021; Zulu et al., 2021; Schulte et al., 2022; Shakeel et al., 2023; Siitonen et al., 2024). Earlier research primarily concentrated on countries with established carbon emission reduction strategies (Asif et al., 2022). In Vietnam, prior studies have pointed out the crucial role of government incentives in encouraging households to adopt solar systems (Nguyen et al., 2022; Jirakiattikul et al., 2021). Nevertheless, Vu et al. (2023) found that such incentives did not have a positive effect on adoption intentions. This indicates a research gap that highlights the need for further exploration of how recent policy revisions could better promote the adoption of solar systems nationwide. Factors such as environmental concern and environmental knowledge, which have been explored within the framework of the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB), have been examined in various settings with differing results. Despite this, a thorough analysis of these factors in the specific context of Vietnam remains largely unaddressed in previous research. This gap provides the primary impetus for our study, which aims to contribute valuable insights to this field. Based on previous literature, we propose the research model and following hypotheses:

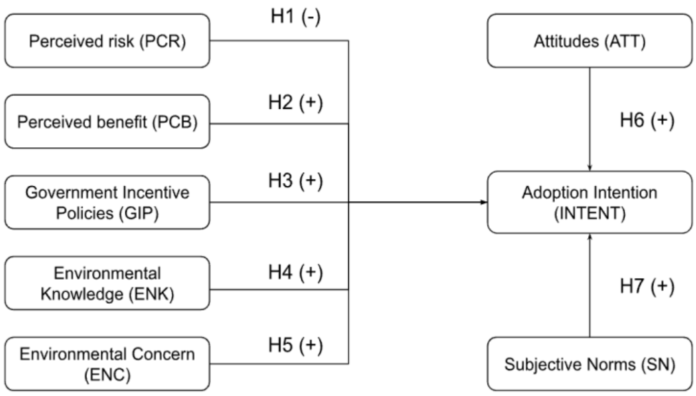

Figure 1: Research model

Source: Authors

Hypothesis 1 (H1): Perceived Risk (PCR) has a negative effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 2 (H2): Perceived Benefit (PCB) has a positive effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 3 (H3): Government Incentive Policies (GIP) have a positive effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 4 (H4): Environmental Knowledge (ENK) has a positive effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 5 (H5): Environmental Concern (ENC) has a positive effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 6 (H6): Attitudes (ATT) have a positive effect on Adoption Intention (INTENT) towards solar PV technology.
Hypothesis 7 (H7): Subjective Norms (SN) have a positive effect on Adoption Intention (INTENT) towards solar PV technology.

2. Methods

Our study targeted urban areas in Northern Vietnam, focusing on electricity demand in the first quarter of 2024. Data was collected via a convenience sampling method through an online survey conducted in March 2024. Participants from Northern Vietnam responded voluntarily to a Google Forms questionnaire distributed via Facebook and Zalo. Using a 5-point Likert scale, we gathered 268 valid responses, which met our research criteria for analysis.

The questionnaire is split into two parts: the "Introduction" with five demographic questions (covering gender, age, education, income, and marital status) and the "Research Framework and Formulation of Hypotheses", which features 24 questions on specific constructs. Each construct is assessed using three items. Perceived Risks (PCR) are drawn from Tanveer et al. (2021) and Ma et al. (2023), while Perceived Benefits (PCB) is based on Akroush et al. (2019). Government Incentive Policies (GIP) are referenced from Vu et al. (2023), and Environmental Knowledge (ENK) is sourced from Asif et al. (2022) and Vu et al. (2023). Environmental Concern (ENC) is adapted from Irfan et al. (2021) and Asif et al. (2022). Attitudes (ATT) are informed by Aggarwal et al. (2019), Asif et al. (2022), and Vu et al. (2023), while Subjective Norms (SN) come from Asif et al. (2022) and Vu et al. (2023). Finally, Adoption Intention towards Solar PV (INTENT) is measured based on Khoo et al. (2023).

Using the convenience sampling method, out of 300 questionnaires collected, 268 were considered valid and included in the analysis. The respondent profile shows a predominantly male demographic, with 66.23% identifying as male and 33.77% as female. Most respondents are between 26 and 35 years old (42.30%), followed by those aged 36 to 45 years (32.13%), while younger (8.20%) and older (17.38%) age groups are less represented. The majority have completed college (59.67%), with fewer holding undergraduate (14.75%) or postgraduate degrees (25.25%). In terms of income, the largest group earns between 30,000,000 and 40,000,000 VND per month (37.38%), with significant numbers also in the 20,000,000 to 30,000,000 VND range (31.48%). Regarding marital status, 62.30% are married, 29.18% are single, and a smaller percentage are either widowed (1.49%) or divorced (4.85%). This profile reflects a well-educated, predominantly male, middle-aged sample with a strong representation of married individuals and a diverse income distribution.

3. Results

3.1. Cronbach's Alpha reliability test

Nunnally and Bernstein (1978) define a scale as reliable when the Cronbach's Alpha coefficient (α) is at least 0.7. Hair et al. (2010) note that while a Cronbach's Alpha of 0.6 may sometimes be acceptable, it should be interpreted cautiously. A higher Cronbach's Alpha generally signifies greater scale reliability. The Corrected Item-Total Correlation should generally be 0.30 or higher to be considered acceptable. Values below 0.30 may indicate that an item does not contribute well to the overall scale and might need revision or removal.

Table 1: Cronbach's Alpha reliability test

Construct	Code	Cronbach's α	Corrected item-total correlation		The number of items eliminated
			Lower bound	Upper bound	
Perceived risk	PCR	0.918	0.812	0.850	0/3
Perceived benefit	PCB	0.861	0.711	0.782	0/3
Government Incentive Policies	GIP	0.930	0.849	0.862	0/3
Environmental Knowledge	ENK	0.904	0.797	0.826	0/3
Environmental Concern	ENC	0.815	0.611	0.699	0/3
Attitudes	ATT	0.913	0.784	0.862	0/3
Subjective Norms	SN	0.872	0.716	0.801	0/3
Adoption Intention	INTENT	0.900	0.784	0.821	0/3

Source: Authors' research

In Table 1, all constructs in your study demonstrate strong internal consistency with Cronbach's Alpha values indicating excellent to good reliability. The item-total correlations are generally high, suggesting that the items are well-aligned with their respective constructs. No items were eliminated from any scale, which suggests that all items are contributing effectively to the measurement of the constructs. In other words, all items met the criteria to be analyzed in the next step.

3.2. Confirmatory factor analysis (CFA)

Then we conducted Confirmatory Factor Analysis (CFA). The results in table 2 indicate that the model fits the data well. The CMIN/df value is 1.459, which falls within the acceptable range of 1 to 3, suggesting a reasonable fit (Hu & Bentler, 1999). The GFI (Goodness of Fit Index) is 0.911, which is greater than 0.9, indicating a good fit of the model to the data. Similarly, the CFI (Comparative Fit Index) is 0.976, exceeding the threshold of 0.9, confirming that the model fits well. Lastly, the RMSEA (Root Mean Square Error of Approximation) is 0.041, which is less than 0.05, showing an excellent fit of the model. Based on these indices, the model is considered well-fitted to the data.

Table 2: Model Fit

	Index	Conclusion	Source
CMIN/df	1.459	Accepted (CMIN/df value between 1 and 3)	(Hu & Bentler, 1999)
GFI	0.911	Accepted (GFI > 0.9)	
CFI	0.976	Accepted (CFI > 0.9)	
RMSEA	0.041	RMSEA < 0.05 (The model fits very well)	

Source: Authors' research

Table 3 presents the model validity measures, including Composite Reliability (CR), Average Variance Extracted (AVE), and Maximum Shared Variance (MSV). All constructs show high internal consistency, with CR values exceeding 0.8, which is well above the acceptable threshold of 0.7 (Bagozzi & Yi, 1988). The AVE values, indicating convergent validity, are all above 0.5, which confirms that the constructs account for a substantial amount of variance. Additionally, the MSV values are lower than the AVE values, which supports discriminant validity, showing that the constructs are distinct from each other (Fornell & Larcker, 1981). Overall, the model exhibits strong reliability, convergent validity, and discriminant validity.

Table 3: Model Validity Measures

	CR	AVE	MSV	ENC	PCR	ENK	PCB	GIP	INTENT	ATT	SN
ENC	0.818	0.601	0.181	**0.775**							
PCR	0.920	0.793	0.159	-0.218	**0.891**						
ENK	0.905	0.761	0.280	0.283	-0.340	**0.872**					
PCB	0.863	0.677	0.280	0.250	-0.399	0.529	**0.823**				
GIP	0.931	0.817	0.126	0.240	-0.051	0.053	0.149	**0.904**			
INTENT	0.902	0.754	0.207	0.397	-0.327	0.455	0.442	0.355	**0.868**		
ATT	0.915	0.783	0.198	0.426	-0.308	0.445	0.314	0.224	0.437	**0.885**	
SN	0.875	0.700	0.056	0.158	0.237	0.012	0.060	0.170	0.194	0.038	**0.837**

Source: Authors' research

3.3. Structural equation modeling (SEM)

After identifying the relationships between the variables in the model and testing the model fit, a Structural Equation Modeling (SEM) analysis is performed as follows.

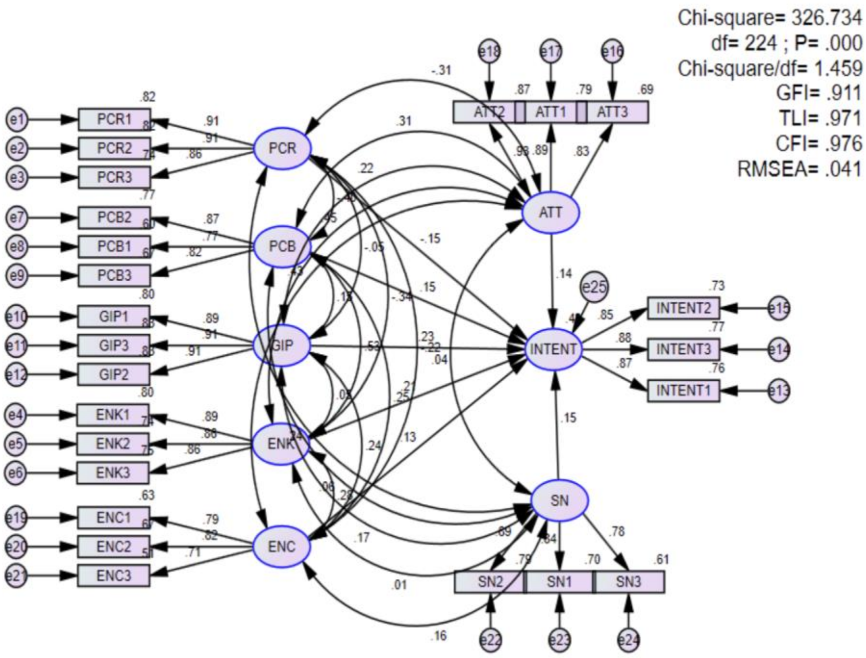

Figure 2: SEM results

Source: Authors' research

In Table 4, the relationship between Perceived Risks (PCR) and Intention (INTENT) is statistically significant, with a β coefficient of -0.113 and a p-value of 0.023. This indicates a negative association, suggesting that higher perceived risks are linked to a lower intention to engage in adoption for solar PV. The results of this study align with the findings of Tanveer et al. (2021). Perceived Benefits (PCB) also shows a significant positive impact on Intention (INTENT), with a β coefficient of 0.158 and a p-value of 0.036, highlighting that increased perceived benefits enhance the intention to adopt solar PV. These results align with those reported by Irfan et al. (2021).

Government Incentive Policies (GIP) demonstrate a strong positive influence on Intention (INTENT), with a β coefficient of 0.204 and a highly significant p-value of 0.000. This underscores the significant role that supportive government policies play in increasing engagement intention. Meanwhile, the result is in contrast with those reported by Vu et al. (2023) - government incentive policies were found to have no positive effect on the intention to adopt. However, earlier research conducted in Vietnam also emphasized that government incentives play a crucial role in motivating households to adopt solar energy systems (Nguyen et al., 2022; Jirakiattikul et al., 2021).

Similarly, Environmental Knowledge (ENK) positively affects Intention (INTENT), with a β coefficient of 0.179 and a p-value of 0.004, indicating that greater environmental knowledge is associated with a higher intention to engage in the behavior. This finding contributed to Zheng et al. (2018). Individuals with greater environmental knowledge are more likely to engage in environmentally positive behaviors, whereas those with less environmental knowledge generally exhibit fewer such behaviors. On the other hand, the relationship between Environmental Concern (ENC) and Intention (INTENT) is not statistically significant, with a β coefficient of 0.139 and a p-value of 0.054, which exceeds the conventional significance level of 0.05. This suggests that environmental concern does not have a significant impact on intention. This result contradicts the conclusions of Irfan et al. (2021), which indicated that environmental concern has a substantial effect on consumers' willingness to adopt solar energy technologies.

Attitudes (ATT) show a significant positive effect on Intention (INTENT) with a β coefficient of 0.132 and a p-value of 0.042, indicating that more favorable attitudes lead to a higher intention to engage in the behavior. Subjective Norms (SN) also positively influence Intention (INTENT), with a β coefficient of 0.194 and a p-value of 0.011, demonstrating a significant association. This suggests that stronger subjective norms are related to increased intention to participate in the behavior. The findings support the principles outlined in the TRA model (Ajzen & Fishbein, 1980).

Table 4: Summary of Structural Model Results

	Independent variables	Dependent variables	β	Sig.	Results
H1	PCR	INTENT	-0.113	0.023	Supported
H2	PCB	INTENT	0.158	0.036	Supported
H3	GIP	INTENT	0.204	0.000	Supported
H4	ENK	INTENT	0.179	0.004	Supported
H5	ENC	INTENT	0.139	0.054	Rejected
H6	ATT	INTENT	0.132	0.042	Supported
H7	SN	INTENT	0.194	0.011	Supported

Source: Authors' research

4. Conclusion

Overall, our findings reveal that Perceived Risks (PCR) has a negative impact on Intention (INTENT), meaning that higher perceived risks are associated with a lower intention to adopt solar PV. Conversely, Perceived Benefits (PCB), Government Incentive Policies (GIP), Environmental Knowledge (ENK), Attitudes (ATT), and Subjective Norms (SN) all positively influence Intention. This indicates that greater perceived benefits, supportive government policies, increased environmental knowledge, favorable attitudes, and stronger subjective norms contribute to a higher intention to adopt solar PV. On the other hand, Environmental Concern (ENC) does not have a significant effect on Intention, suggesting that concern for the environment alone does not substantially impact the adoption decision.

Based on what has been discussed above, to enhance the adoption of solar photovoltaic (PV) systems, it is crucial for the government to continue and expand its incentive programs. This includes increasing subsidies, offering tax credits, and providing low-interest loans. Such financial incentives can significantly reduce the initial costs of solar PV systems, making them more accessible and attractive to households. The government should invest in educational campaigns and public awareness programs that highlight the benefits of solar energy. By improving public knowledge about environmental issues and the advantages of solar PV systems, the government can foster a more informed and supportive attitude towards solar energy adoption.

Solar PV companies should prioritize clear and effective communication about the benefits of solar PV systems. This involves providing comprehensive information on cost savings, energy efficiency, and environmental impact. Developing targeted marketing strategies and educational materials can help increase perceived benefits and drive higher adoption rates. Firms should implement strategies to alleviate consumer concerns about solar PV systems. This includes offering transparent information about system reliability, maintenance, and financial incentives. Additionally, providing robust customer support and warranty services can help mitigate perceived risks and build consumer trust.

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Taiwan's Environmental Policies and Implications for Vietnam

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Abstract

The economic prosperity that Taiwan currently enjoys can be attributed, in part, to nearly fifty years of strategic governmental planning. With a focus on sustainable development, Taiwan has consistently adapted its policies to safeguard the environment, mitigate pollution, and explore green energy alternatives. Leveraging its strengths in technology and innovation, Taiwan's experiences in environmental protection serve as a valuable reference for numerous countries both regionally and globally, including Vietnam. This research employs qualitative methodologies, synthesizing and analyzing secondary data to identify Taiwan's notable environmental policies in recent years. The findings indicate that Taiwan not only prioritizes the implementation of domestic environmental initiatives but also enhances international collaboration in this domain. By examining the effectiveness and certain limitations of these policies, the study proposes several recommendations for Vietnam to address its environmental challenges.

Keywords: *Environmental policy, sustainable development, Taiwan, Vietnam*

1. Introduction

Taiwan, recognized as one of the Four Asian Tigers, is positioned 8th in the 2024 IMD World Competitiveness Ranking. Taiwan encounters significant challenges in its dual transformation towards digitalization and achieving net-zero emissions, which are essential for enhancing its competitiveness while addressing geopolitical tensions and climate change. Taiwan's capabilities in green technology, which are applied in areas such as disaster response, environmental conservation, public health, and renewable energy, underscore its commitment to global citizenship (IMD, 2016). Furthermore, Vietnam serves as a vital partner for Taiwan across multiple domains, including economic collaboration, educational exchange, cultural interaction, and environmental initiatives. The green technology policies implemented by Taiwan are poised to offer Vietnam valuable insights and practical experience in tackling environmental challenges and promoting sustainable development.

This study offers an examination of Taiwan's policies and their implications for Vietnam, highlighting both academic relevance and practical importance. This paper also serves as a valuable resource for individuals seeking information about Taiwan broadly, with a specific focus on the Taiwan's environmental policies. Additionally, the research offers policy recommendations that can be taken into account by local policymakers.

This study seeks to elucidate several key aspects. First, it examines Taiwan's exemplary environmental policies that have emerged in recent years, particularly during the administration of President Tsai Ing-wen. Second, it evaluates the efficacy of these policies by assessing the progress Taiwan has achieved in their execution. Furthermore, it highlights the constraints and obstacles encountered by the Taiwanese government in the formulation and implementation of environmental policies. Lastly, it offers some recommendations for policy implicatons to Vietnam.

2. Literature review

There have been several analyses of Taiwan's environmental policies, featuring certain highlights. Taiwan has adopted a greening policy for production and recycling, which is controlled by the Environmental Protection Administration through the Recycling Fund Management system. The goal is to reduce environmental pollution and promote appropriate recycling methods (Nambu and Murakami, 2016). Particularly, Taiwan has implemented extensive and effective environmental regulations to safeguard its environment from fast industrialization, including constant enhancement of laws, monitoring, analyzing, and sharing environmental data with the public (Ertan, 2021). Since 2022, Taiwan has enacted regulatory measures to restrict the use of plastic products, but recent data reveal that the impact has been minimal. This reflects the unforeseen environmental repercussions of the COVID-19 pandemic, which elevated chlorine levels in garbage, impacting recycling efforts (Tsai, 2022). Furthermore, Taiwan's "2025 Non-Nuclear Homeland" policy has been regarded as an effective initiative aimed at reducing carbon emissions, demonstrating Taiwan's proactive environmental policy approach for achieving emission reduction targets (Yang et al, 2022). Taiwan's environmental movement has been evolved and divided over petrochemicals, coal and nuclear power, hydropower, agriculture, wind energy, titanium, and electronics (Martínez-Alier, 2023). Taiwan has also set aggressive aims to cut carbon emissions from the road transportation sector, aiming to reduce emissions by 50% below 2005 levels by 2050 by policies such as prohibiting gas-powered automobiles and introducing gasoline rationing (Chang et al., 2024). Despite certain obstacles, Taiwan has demonstrated progress toward the sustainable development goals and serves as a potential benchmark for other countries (Mokhtar, 2024). Those research indicates that Taiwan has successfully implemented environmental policies as a result of industrialization, ongoing revisions, evaluations, and transparency in public reporting. Nonetheless, there are notable research gaps, particularly regarding the challenges encountered during the implementation of these policies and the absence of comparative analyses with other nations. This study seeks to fill these gaps and draw implications for Vietnam by leveraging both the academic insights and practical experiences derived from Taiwan's approach.

3. Methods

This study uses a qualitative approach in social sciences, utilizing various methodologies to analyze the research issue. The analysis and synthesis method involves gathering and processing secondary data from reliable sources, such as books and publications from foreign publishers and Taiwan's Ministry of Environment. The comparison approach compares and contrasts variables to determine differences, often using tables, graphs, or charts to visually represent the findings. The study also examines national policy analysis in Vietnam, focusing on the Communist Party's principles and values, to understand its implications for environmental policy.

4. Results

Taiwan registered as an NGO observer at the 28th Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change (FCCC), held in Dubai, United Arab Emirates on November 30, 2023, despite not being a UN member. This action showed that Taiwan actively participated in climate convention activities and pledged to take international environmental action (MOENV, March 2024). Domestically, Taiwan has recently initiated environmental measures across different sectors, such as enacting legislation, implementing systems, and formulating policies.

The National Environmental Protection Plan, which was approved on February 14, 2020, is in accordance with the United Nations Agenda 2030 for Sustainable Development. Its objectives include the reduction of carbon emissions and disaster risks, the promotion of relaxation and well-being, the provision of clean water, the conversion of waste into resources, the achievement of zero deforestation, and the harmonious coexistence with wildlife by the year 2030. Among its primary targets are a 20% reduction in greenhouse gas emissions, the enhancement of air quality for outdoor activities, the decrease of severely polluted sections in 50 rivers, and an increase in overall waste recycling rates (MOENV, October 2020). The plan advocates for collaboration among government agencies, businesses, organizations, and the public to advance environmental protection efforts, thereby fostering environmental safety, and sustainable living practices.

On Earth Day 2022, President Tsai Ing-Wen of Taiwan declared the nation's commitment to achieving net zero emissions by the year 2050. The comprehensive framework titled "Pathway to Net-Zero Emissions and Strategies in 2050" delineates twelve pivotal strategies, which encompass the utilization of wind and solar energy, enhancements to the electric grid and energy storage systems, improvements in energy efficiency, carbon capture technologies, the electrification and decarbonization of transportation, resource recycling initiatives, zero-waste practices, natural carbon absorption methods, promotion of sustainable living, green finance mechanisms, and ensuring an equitable transition. Successively, on December 28, 2022, the National Development Council unveiled the "Action Plan for the 12 Key Strategies in Transitioning Towards Net-Zero Emissions," signaling the commencement of Taiwan's transformative journey. This plan is intended to establish a basis for ongoing public engagement aimed at refining implementation strategies (MOENV, August 2023).

An exemplary legislative measure is The Climate Change Response Act, which was enacted on 15 February 2023. This act revises and updates the National Climate Change Action Guidelines, which are essential for climate governance in Taiwan. The amendments are designed to align with global climate agreements and underscore the importance of both mitigation and adaptation strategies, aiming for net-zero emissions by the year 2050 (MOENV, March 2024). Furthermore, it incorporates principles of just transition, risk assessment, and nature-based solutions. These guidelines will underpin Taiwan's strategies for climate change adaptation and its Pathway to Net-Zero Emissions, thereby promoting sustainable development at the national level. The National Climate Change Adaptation Action Plan (2023-2026) was also ratified on October 4, 2023, with the purpose of protecting lives and fostering sustainable development in Taiwan. This initiative seeks to tackle the notable rise in Taiwan's average annual temperatures observed over the past fifty years. An investment of NT$411.6 billion has been designated for 126 projects, comprising 78 that are currently in progress and 48 that are newly initiated. The primary goals of the plan include bolstering the resilience of critical infrastructure, enhancing climate adaptation capabilities, stabilizing water resources, and ensuring national security (MOENV, October 2023).

On December 21, 2023, MOENV introduced the Phase II Air Pollution Control Plan (covering the period from 2024 to 2027) as a continuation of the Phase I Air Pollution Control Plan (implemented from 2020 to 2023) over the past 4 years. A budget of approximately NT$76.6 billion will be allocated for 37 specific reduction measures across 8 different areas, utilizing effective governance, transitioning to net-zero, pollution and emission reduction strategies, and leveraging the capabilities of 9 government departments. The objective is to reduce the average concentration of particulate matters (PM2.5) to 13 µg/m3 by 2027, and decrease the number of days with eight-hour ozone concentration exceeding red-alarm levels by 80% compared to the levels in 2019 (MOENV, March 2024). This demonstrates that enhancing air quality and safeguarding public health is the core of Taiwan's environmental protection endeavors. On December 29, 2023, the Ministry of Environment (MOENV) amended the Enforcement Rules of the Greenhouse Gas Reduction and Management Act, transitioning them to align with the Enforcement Rules of the Climate Change Response Act. This revision was prompted by substantial modifications made to the Greenhouse Gas Reduction and Management Act on February 15, 2023 (MOENV, August 2024). The amendments encompass a redefinition of the responsibilities of both central and local authorities, the establishment of assessment criteria, the enhancement of regular monitoring practices, the integration of mitigation goals into strategic action plans, and the formulation of guidelines for public participation. Moving into 2024, Taiwan has been consistently implementing a plenty of major environmental policies that are presented in Table 1.

Table 1: Major Environmental Policies

Date	Titles	Summary
May, 2024	Amended Permit Management Regulations Announced Concerning Waste Clearance and Disposal Organizations	The goal is to improve the review process of waste clearance and disposal organizations, establish clear permit issuing principles, and align pollution flow tracking with environmental permit registration details.
May, 2024	Garbage Collection at Fixed Hours and Locations Enhances Cleaning Crew Safety	In 2024, a NT$5,996,680 subsidy was granted for 48 trial routes in 11 cities and counties to enhance safety and provide diverse disposal options during garbage collection.
May, 2024	Environmental Management Administration Promotes Voluntary Pollution Management	The objective is to promote voluntary compliance in the industrial sector, aiming to transition to clean production practices and collaborate with the government for a more sustainable world.

Date	Titles	Summary
May, 2024	Carbon Fee Collection to Be Based on International Practices Focused on Transition	The MOENV emphasized that the purpose of implementing carbon fees is to accelerate CO2 emissions reduction and promote industrial transition, not to boost government income.
April, 2024	Tightened Air Quality Standards Drafted to Reduce Pollutions in Central and Southern Regions	The proposed revision of the Air Quality Standards is founded on research findings from the National Health Research Institute and accounts for the current air quality situation in Taiwan.

Source: Department of Environmental Protection, MOENV - August 2024

The funding for Taiwan's environmental agencies has shown a consistent annual increase, surpassing NT$65,000,000 in 2024. A substantial portion of this budget is dedicated to administrative costs, which vary between 10% and 15% of the overall budget. Noteworthy shifts in budget distribution among agencies from 2021 to 2022 include a remarkable twenty-fold rise in the Air Quality Protection budget, escalating from NT$139,421 to more than NT$2,800,000, alongside a significant boost in the Greenhouse Gas Reduction & Management sector, which increased from NT$85,733 to NT$538,873. Other budget categories exhibit varying degrees of fluctuation (Figure 2).

Table 2: Budget of Environmental Protection Agencies

Period	Total	Administration	Comprehen-sive Planning	Research & development	Air Quality Protection	Greenhouse Gas Reduction & Management	Noise & Vibration Control	Water Quality Protection
	1,000NT$	1,000NT$	1,000NT$	1,000NT$	1,000NT$	1,000NT$	1,000NT$	1,000NT$
2016	47,604,100	6,441,225	329,258	91,455	68,860	—	58,510	765,350
2017	51,216,213	6,496,964	488,533	164,972	189,352	—	94,300	918,997
2018	51,137,665	12,156,072	493,926	140,651	41,932	—	86,113	1,044,007
2019	53,430,433	11,516,646	604,267	115,590	48,816	—	74,120	875,613
2020	53,382,212	11,538,185	575,316	146,825	38,904	—	69,370	555,982
2021	55,650,843	10,976,404	599,048	101,316	139,421	85,733	43,761	1,012,592
2022	57,628,243	11,000,583	649,267	83,628	2,818,896	75,337	46,356	742,269
2023	61,186,382	11,621,120	619,221	806,045	2,816,959	199,533	40,624	1,005,595
2024	65,095,331	7,709,965	812,436	859,216	366,729	538,873	103,089	889,370

Source: Department of Accounting, MOENV - 2024

Taiwan also places a strong emphasis on national policies while promoting international cooperation in the environmental domain. The MOENV plays a pivotal role in facilitating both bilateral and multilateral partnerships aimed at tackling intricate environmental challenges. Since 1993, the Ministry of Environment of Taiwan and the Environmental Protection Agency of the United States have entered into the Taiwan-U.S. While the initial emphasis was on strengthening Taiwan's environmental capabilities, the partnership has progressed to enhance regional and global environmental protection efforts by disseminating Taiwan's knowledge and expertise to the international community. Since 2020, representatives from Taiwan's Environmental Protection Administration have participated in the European Commission's National Expert Professional Training Program. This engagement has facilitated the acquisition of knowledge, the alignment of environmental protection policies, the enhancement of environmental expertise, and the reinforcement of collaborative efforts between Taiwan and the European Union (MOENV, January 2024).

On September 18, 2023, the MOENV convened a forum focused on advancing innovative wastewater treatment technologies and fostering collaboration between Taiwan and India. This event highlighted various research and development efforts, culminating in a cooperation agreement between the Water Association of Taiwan and the Micro, Small, and Medium Enterprises Chamber of Commerce and Industry of India, which seeks to broaden the wastewater sector and improve bilateral interactions

(MOENV, December 2023). Two months later, on October 25, the MOENV, in collaboration with the German Institute Taipei, organized the 2023 Taiwan-Germany International Seminar focused on the Transition Toward a Zero-Waste Lifestyle. The seminar sought to advance sustainable living practices, enhance public awareness, stimulate behavioral modifications, and advocate for a sharing economy, thereby generating important insights for future initiatives aimed at lifestyle transformation.

The Environmental Protection Agency (EPA) of Taiwan plays a proactive role in environmental conservation efforts within various international frameworks, including the Asia-Pacific Economic Cooperation (APEC), the World Trade Organization (WTO) (MOENV, March 2024). In alignment with global environmental trends, Taiwan formulates adaptive strategies that reflect its commitment to its responsibilities as a member of the international community. In spite of facing political obstacles, Taiwan has engaged in more than 130 environmental initiatives in collaboration with nations such as Mongolia, the US, Canada, Japan, and the European Union (Dang, 2007).

In recent years, Taiwan has undertaken a range of environmental policies characterized by notable diversification and strong enforcement measures. This development can be largely credited to the administration of President Tsai Ing-wen, which has demonstrated a commitment to sustainable development. Furthermore, Taiwan's proactive engagement in global affairs has emphasized environmental concerns, leveraging technology and innovation as key factors of its strategy.

5. Discussion and Conclusion

5.1. Achievements

Over the past seven years, Taiwan has achieved notable advancements in enhancing air quality, evidenced by a substantial reduction in pollutant levels (Figure 3). The proportion of days classified as having poor air quality decreased from 15.24% in 2017 to 6.33% in 2023. Furthermore, the average annual concentration of PM2.5 has seen an improvement exceeding 30%. Emissions from factories have been reduced by 38%, while transportation-related emissions have declined by 30%. Key initiatives aimed at mitigating pollution include the transition from commercial and industrial boilers to natural gas alternatives, the gradual elimination of large diesel vehicles, and a 63% reduction in older motorcycles. Collectively, these measures have resulted in a marked enhancement of air quality (MOENV, March 2024).

Table 3: Air Quality Index (AQI)

Period	Days by AQI Level					
	Good 0-50	Moderate 51-100	Unhealthy for Sensitive Groups 101-150	Unhealthy 151-200	Very Unhealthy 201-300	Hazardous 301-500
	%	%	%	%	%	%
2017	39.72	42.20	15.24	2.79	0.05	—
2018	42.49	41.50	13.50	2.47	0.04	—
2019	47.87	39.23	11.13	1.76	0.01	—
2020	54.22	35.73	8.98	1.02	0.05	—
2021	51.76	38.45	8.77	1.01	—	—
2022	59.61	34.00	5.89	0.48	0.01	—
2023	52.16	41.03	6.33	0.48	—	—

Source: Department of Monitoring and Information, MOENV - 2024

In 2022, Taiwan made notable progress regarding greenhouse gas emissions, contrasting sharply with the global trend of rising emissions post-pandemic, which reached an unprecedented 53.8 GtCO2e, reflecting a 1.37% increase from the prior year. The International Energy Agency indicated a 1.3% increase in global energy-related emissions for the same year. In contrast, Taiwan recorded a reduction in both total greenhouse gas emissions and energy-related emissions, highlighting a divergent trajectory from that of other nations amid the global recovery phase (MOENV, July 2024). Additionally, Taiwan's success in decoupling economic growth from greenhouse gas emissions was recognized on a global scale. It experienced a notable increase in economic growth rate by 2.60% in 2022 compared to the previous year, surpassing many advanced international counterparts (MOENV, 2024). This achievement, as illustrated in Figure 4, highlights the significant progress made in reducing greenhouse gas emissions while promoting economic growth. It reflects the effectiveness of our initiatives to foster green growth and transition towards a low-carbon economy. Despite the challenges faced in balancing emission reductions with economic recovery, Taiwan has emerged as a leader in global efforts towards sustainability.

Table 4: Comparison of Greenhouse Gas Emissions & Economic Growth in Various Countries in 2022

Country	Greenhouse gas growth rate in 2022 compared to 2021	Economic growth rate in 2022 compared to 2021
Finland	-4.5%	+2.1%
Taiwan	**-3.78%**	**+2.6%**
France	-2.8%	+2.6%
Singapore	-1.2%	+3.6%
Germany	-1.1%	+1.8%
South Korea	-0.7%	+2.6%
United Kingdom	+0.2%	+4.1%
China	+0.3%	+3.0%
Japan	+0.6%	+1.0%
United States	+1.6%	+2.1%

Source: MOENV - July 2024

Taiwan's environmental initiatives have significantly advanced the development of green industries and the generation of renewable energy, positioning the nation as the second largest globally in the research and production of solar battery systems. Additionally, Taiwan is a key producer of LED lighting, electric bicycles, recycled textiles, and glass products. The implementation of solar energy technologies, such as solar-powered streetlights, pumps, and LED fixtures, not only provides natural illumination but also contributes to lower electricity expenses and diminished carbon emissions. Remarkably, these products can be recycled at rates exceeding 95%. Furthermore, Taiwan's micro-grid system, which integrates storage batteries, is being deployed in various countries, including Indonesia, India, and Japan (Thu and Tran, 2020). Besides, Taiwan has achieved notable advancements in the management of solid waste, primarily through the implementation of effective policies aimed at urban and industrial waste. According to the Resource Circulation Administration (2024), the total amount of industrial waste has declined from 21,950,312 tonnes in 2021 to 20,038,745 tonnes in 2023. Additionally, there has been a reduction in the volume of hazardous waste. The increase in the number of waste disposal facilities, from 148 to 161, further illustrates the government's commitment to reducing environmental impact.

5.2. Challenges

Although there have been encouraging developments following the introduction of various environmental policies aimed at sustainable development, Taiwan continues to encounter certain issues and challenges. Notwithstanding there have been improvements in various forms of pollution, the number of public nuisance petition cases remains substantial, despite the variable trends observed in recent years (see Table 5). In 2021, the total count of such cases reached 279,383. This figure saw a decline to 242,796 in 2022, followed by a rise to 264,315 in 2023. It is important to highlight that the preceding years from 2016 to 2020 also experienced consistent fluctuations, both increases and decreases, on an annual basis. A significant portion of these cases, nearly 60%, pertained to noise pollution and unpleasant odors. This situation can be linked to the responsibilities of the implementing agencies, as well as the challenges associated with the effectiveness and sustainability of existing environmental policies.

Table 5: Public Nuisance Petition Cases

Period	Total	by Pollutants							
		Air (Exclude Unusual Smell Pollutant)		Unusual Smell Pollutant		Noise		Water Pollution	
	Cases	Cases	%	Cases	%	Cases	%	Cases	%
2016	261,656	10,311	3.94	84,949	32.47	83,749	32.01	8,499	3.25
2017	276,536	11,175	4.04	93,265	33.73	83,833	30.32	8,706	3.15
2018	281,302	11,377	4.04	94,005	33.42	87,995	31.28	8,378	2.98
2019	276,933	10,738	3.88	89,927	32.47	85,457	30.86	8,043	2.90
2020	279,622	10,494	3.75	89,006	31.83	91,928	32.88	6,921	2.48
2021	279,383	10,258	3.67	83,256	29.80	96,806	34.65	6,587	2.36
2022	242,796	8,328	3.43	66,117	27.23	91,081	37.51	5,432	2.24
2023	264,315	9,498	3.59	67,144	25.40	91,654	34.68	5,997	2.27

Source: Local Environmental Protection Bureaus - 2024

The environmental protection framework in Taiwan encounters difficulties stemming from the conflicting interests of various stakeholders and the relaxation of regulations for large corporations. Although there is an emphasis on collaboration between governmental bodies and the public, the implementation of environmental policies at the local level can differ markedly. Furthermore, the increasing tendency to relax regulations may impede the overall effectiveness of these initiatives (Grano, 2015). Taiwan's environmental policy is also confronted with numerous obstacles, including the strain on natural ecosystems resulting from swift economic expansion (Martínez-Alier, 2023), the difficulties in applying ecosystem-based disaster risk reduction methods in coastal areas (Van et al, 2023), insufficient global responses to climate change, and ongoing debates regarding high-carbon energy sources and nuclear power at the national level (Liu and Chao, 2023). Additionally, there are significant challenges in incorporating strategic environmental assessment (SEA) into policy planning due to institutional and political hurdles (Wu and Ma, 2019). Furthermore, the lack of progress in establishing sustainable environmental governance and justice has resulted in an uneven distribution of improvements in air quality and various forms of environmental injustice (Chou and Walther, 2022). These issues underscore the intricate relationship between economic growth, environmental stewardship, and social equity that Taiwan must address to strengthen its environmental policy framework.

The aforementioned constraints necessitate significant policy deliberation by Taiwan in the near future. Nevertheless, the beneficial impacts of existing policies on Taiwan's environment are indisputable. The successes and obstacles encountered in Taiwan's environmental policies offer important insights for numerous countries and regions globally, particularly for Vietnam. Taiwan and Vietnam have engaged in collaboration across various sectors, including economics, culture, education, and environmental initiatives.

The process of industrialization and modernization in Vietnam is significantly impacted by climate change, necessitating a shift towards more sustainable and environmentally friendly industries. By examining Taiwan's effective strategies in promoting green industry and renewable energy, Vietnam has the opportunity to enhance its environmental policies to better tackle both social and ecological issues. Furthermore, the 13th Party Congress of the Communist Party of Vietnam has established 12 strategic directions for national development for the period of 2021-2030. These directions address critical developmental challenges, such as adapting to climate change, mitigating natural disasters, preventing epidemics, safeguarding health, managing resources, and protecting the environment (Communist Party of Vietnam, 2021). Collectively, these directions serve as the basis for Vietnam's environmental policy implications, ensuring coherence with the nation's strategic goals. Some Vietnam's environmental policies are recommended as follows.

Initially, it is essential for Vietnam to assess its national context alongside the unique attributes of each region, including available resources, infrastructure, technological benchmarks, and business frameworks, in order to determine priority sectors for advancement in the green industry. Subsequently, the government plays a pivotal role in formulating an environmental policy framework that aligns with the directives and perspectives of the Party while taking into account real-world conditions. Critical factors to be addressed in the formulation of environmental policies encompass infrastructure, input from various agencies, organizations, and the general public; the engagement and collaboration of research institutions and private enterprises; as well as the involvement of citizens.

Furthermore, Vietnam should actively promote and communicate the advantages of green growth for both the economy and the environment, while also involving various societal stakeholders, starting from the individual level, in the economic reform process. The government need to align economic growth with environmental sustainability, promote a green economy, minimize waste, lower greenhouse gas emissions, and adopt low-carbon practices. Additionally, it should foster the establishment of a circular economic model to optimize the utilization of resources generated during the production process. Ultimately, Vietnam must enhance its international collaboration to facilitate the exchange of experiences and the transfer of technology. In addition to its commitment to safeguarding the domestic environment and pursuing sustainable development, Vietnam actively participates in the global arena, addressing various international issues.

6. Conclusion

Taiwan has achieved notable progress in its environmental initiatives, leading to enhancements in air quality, a decrease in greenhouse gas emissions, and a boost in economic growth. It has also made considerable advancements in solid waste management, effectively minimizing both industrial and hazardous waste. Nevertheless, challenges persist, including pollution, conflicts among stakeholders, and the need for effective public-private partnerships. Additionally, issues such as economic expansion, climate change, and debates surrounding high-carbon energy sources further complicate environmental matters. It is essential to bolster research and development efforts to ensure Taiwan's sustainable development.

The effects of climate change on Vietnam's industrialization necessitate a transition towards sustainable sectors. Analyzing Taiwan's initiatives in the green industry may help align Vietnam's environmental policies with the objectives of the Communist Party, thereby fostering a green economy, minimizing waste, and enhancing international collaborations.

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Replacing Fossil Fuels with Renewable Energy for Achieving Sustainable Electricity Production in Vietnam: Current State and Recommendation

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Abstract

The main source of electricity generation in developing nations are fossil fuels, which results in significant emissions of greenhouse gases (GHGs) into the atmosphere. Because of the strong reliance on fossil fuel-fired power plants and rapid economic development, it is predicted that Vietnam's GHG emissions will climb dramatically by 2030. This study analyses the reality of electricity production in Vietnam by existing sources (fossil fuels and renewable energy) based on collecting statistical data and national policies from recent reports, to identify the potential of alternative energy and propose suggestions regarding adopting renewable resources. It should be noted that while the applying of green alternatives is expected to result in a significant emission reduction in thermal power sector, the government must still limit the expansion of fossil fuel-fired power plants (particularly coal-fired) for long-term environmental and economical sustainability.

Keywords: *electricity production, fossil fuels, renewable energy, sustainable development*

1. Introduction

The primary sources of energy utilized in electricity production is fossil fuels, which is considered restricted and exhaustible. In addition, the use of fossil fuels leads to the contamination of land, water, atmosphere at a global scale (Tiep at al., 2020). It is mentioned that renewable energy development helps to address concerns of energy security while also diversifying energy sources and protecting the environment (REN21, 2019).

According to Pye et al. (2015), the transition from fossil fuels to renewable energy is a global concern, not only due to the depletion of resources, but also to tackle climate change and pollution. As stated by REN21 (2019), Asia Pacific is at the forefront of renewable energy development; however, there are numerous barriers to the widespread application of these sources in this region compared to the conventional energy resources like coal and gas. The evidence from China and India has shown that the usage of renewable energy relative to total final energy consumption is extremely limited despite possessing great potential of alternative energy (Tiep at al., 2020). The reason is that green energy being inherently more difficult to operate than traditional ones, which somehow prevents the initial phase of renewable energy development from progressing.

For Vietnam, coal-fired and gas-fired thermal power plants provide more than 50% of annual energy supply and are predicted to increase even more by 2030 to fulfill the rising electricity demand (Roy et al., 2022). According to Power Development Plan 8 (PDP8), Vietnamese government has approved strategy for the development of renewable energy, with a concentration on waste-to-energy (WtE) incineration and solar power for 2030 (with a goal to 2050). Regarding to this plan, solar energy will contribute 6% of annual electricity generation (growing up from its current level of 850 MW to 12,000 MW), which is twice and four times greater than the projected install capacity of wind and biomass burning energy correspondingly. As noted by Ministry of Industry and Trade (2020), Vietnam has implemented policies concerning tax-related incentives and investment model flexibility with the objective of encouraging investors and entrepreneurs to invest in establishing renewable energy system.

Nonetheless, there are still a variety of obstacles on the way, which affects the interest of potential investors as well as the growth rate of renewable energy development.

This study is anticipated to provide the overall picture of electricity generation regarding the consumption of existing sources to identify difficulties facing the transition to apply renewable energy in this industry, including key issues: (1) the burden to diminish the dependence on non-renewable sources, (2) the potential of alternative resources in sustainable energy supply, (3) how to expand the exploitation of renewable energy in electricity manufacture.

2. Methods

Qualitative research method is applied in this study, involving summarizing data from recent reports of Vietnam Electricity (EVN), General Statistical Office of Vietnam, related governmental documents, and academic research. Based on the compiled data, the authors provide evaluation on the current level of fossil fuels use and the prospects for exploiting the potential of renewable energy in electricity production.

3. Results

3.1. Electricity generation by source

With an average annual growth rate of 8% over the last decade, electricity demand in Vietnam has grown rapidly, reaching 251 TWh in 2023 (Vietnam Energy Outlook Report, 2024). To be more specific, the North and the South are expected to gain comparable growth rate in terms of electricity requirement, approaching over 210 and 247 billion kWh in 2030 respectively, or totally accounting for about 90%; whereas the share for the Central area will be nearly 10%. The electricity demand forecast for the country up to 2030 is illustrated in the table below.

Table 1: Electricity demand forecast until 2030

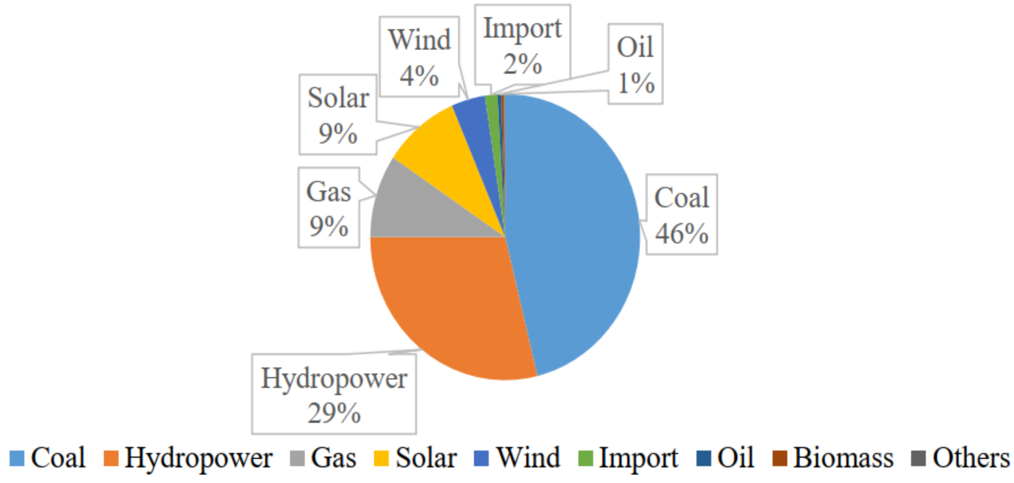
Region	Unit	2020	2025	2030
The North	GWh	95222	145833	210163
The Central	GWh	22230	35056	48603
The South	GWh	116105	171398	247235
Total	**GWh**	**233557**	**352287**	**506001**

Source: Institute of Energy, Analysis of HVDC for PDP8 Vietnam

The total quantity of electricity produced in 2023 was 280,629 thousand MWh, of which 129,577 thousand MWh, or 46%, came from coal power plants that supplied the country's energy grid, and 80,904 thousand MWh, or around 29%, from hydropower plants (EVN Press Release, 2023). Figure 3.1 highlights the percentage of electricity generated by each source in this period.

In Vietnam, the two main energy sources are hydropower and coal-fired plants. Although other energy sources currently make up a minor portion of the electricity supply, they are growing at a rapid rate in response to the demand of the economy as well as the requirement to diversify the energy sector.

Figure 3.1: Electricity generation by source in Vietnam 2023



Source: EVN Press Release 2023

3.2. Current state of using fossil fuels in electricity generation

3.2.1. Coal

During the period of economic expansion (2005-2020), coal held the largest share of the nation's energy mix and was aggressively encouraged by the government. Most of coal-fired power facilities are located close to coal mines. It is cited that 33 coal-fired power stations with a total capacity of over 27 MW are in operation (Ministry of Industry and Trade, 2023). State-owned enterprises possess most of the capacity of the current coal-fired power plants, like Vietnam Electricity - EVN (57%), Petrolimex (11%), and Vinacomin (7%) (EVN Annual Report, 2023).

Vietnam Energy Outlook Report (2024) notes that nearly 35% of all coal used in the country's industrial production, which includes the manufacturing of iron, cement, steel and paper; whereas the left is used for fuel coal-fired power plants, accounting for roughly 63% of the total amount consumed in the electricity field.

Vietnam used to export coal for many years, but since 2015, the country has become a net importer of this fuel. The demand for newly commissioned coal-fired power plants has resulted in a steady increase in coal imports. According to EVN, Vietnam exceeded its own coal production of 11.5 million tons in 2022 with record imports of 54.8 million tons. Coal is mainly imported from Australia, Indonesia, Russia, China, and Canada. The problem of importing coal is made worse by the fact that domestic demand is currently rising, especially for thermal power plants, whereas mining production is still much lower.

EVN made the decision to stop creating new coal power projects and lessen its reliance on this source to reach the commitment regarding carbon neutrality by 2050. Phu Yen, Bac Lieu, Gan Dau, Dung Quat 1-2, Long Son Petrochemical Thermal Power Plant and Son My 1-6 are the six coal-fired power facilities in Vietnam making the switch to liquefied gas (Institute of Energy, 2020).

3.2.2. Natural Gas

Being more ecologically friendly and a good alternative fuel until all the necessary infrastructure, technology, and funding channels for renewable energy have been established; natural gas is essential to the transition process (Vietnam Energy Outlook Report, 2024). Furthermore, natural gas might be used in the future as a long-term backup fuel source.

Even if a full switch to renewable energy is unlikely to occur soon, combining the combustion of hydrogen and natural gas could be one of the most cost-effective, environmentally friendly, and cleanest decisions made by the electric power sector. Whether they are high-power gas-derived turbines or heavy-duty turbines, contemporary gas turbines with carbon capture and sequestration technologies that run on low fuels like hydrogen create electricity with incredibly low or no carbon emissions (Vietnam

Energy Outlook Report, 2024). As demonstrated by South Korea, Japan, and Australia, hydrogen can decarbonize emission-intensive sectors such as transportation, heat generation, and electricity production (Nguyen et al., 2021). Concurrently, updated version of GE gas turbines proved they could run on hydrogen, opening a wide range of options for utilities to cut down emissions.

According to Power Development Plan (PDP8), gas-fired power capacity (including domestic and liquified natural gas) will reach 37,330 MW in 2030, equivalent to 24.8% of total electricity power capacity, occupying the greatest proportion in the power structure. It is noted that natural gas source performs a "regulating" role, compensating for the development of renewable alternatives. It is also the staring point for Vietnam to achieve Net Zero commitment by 2050.

3.2.3. Oil

As stated by PetroVietnam Oil Corporation (PVOIL), Vietnam's oil reserves were expected to rise by 16.97 million tons in 2023, with oil output expected to reach 10.84 million tons, a 24% excess above the yearly plan. Furthermore, to supply the two biggest refineries, Nghi Son and Dung Quat, Vietnam imported 10.2 million tons of crude oil and exported 2.7 million tons in the same year. Nearly 90% of Vietnam's crude oil supply comes from Kuwait, making it the country's main market. Even with the significant oil production, there is still a shortage of technological mastery in oil refining. As a result, Vietnam's oil-fired thermal power facilities are subjected to several restrictions. In 2023, they produced a mere 1267 thousand MWh. Because of numerous challenges and environmental effects, this segment is not thought to be Vietnam’s energy sector for future development direction.

In general, Vietnam has gained significant experience and technology in the development and application of fossil fuels. Undoubtedly, fossil fuels have benefits in Vietnam's thermal energy infrastructure. Power plants, transmission networks, and boiler systems are constructed to operate efficiently by utilizing this energy. For many years, fossil fuels have been a reliable source of electricity generation. At present, fossil fuel-powered plants create a substantial volume of electricity, mostly enough to encounter Vietnam's existing electricity demand. Even though fossil fuels contribute significantly to Vietnam's electrical supply, the following variables affect the transition to renewable energy sources:

- CO2 emissions from burning fossil fuels lead to environmental damage and climate change. Vietnam is under pressure to lessen its reliance on fossil fuels.
- The price of fossil energy may fluctuate depending on market conditions and global events. This might cause price volatility and undermine the energy sector's stability.
- Infrastructure constraints and the depletion of high-class fossil energy sources prevent their full utilization. This demonstrates the growing need of importing coal, oil, and gas for energy generation.

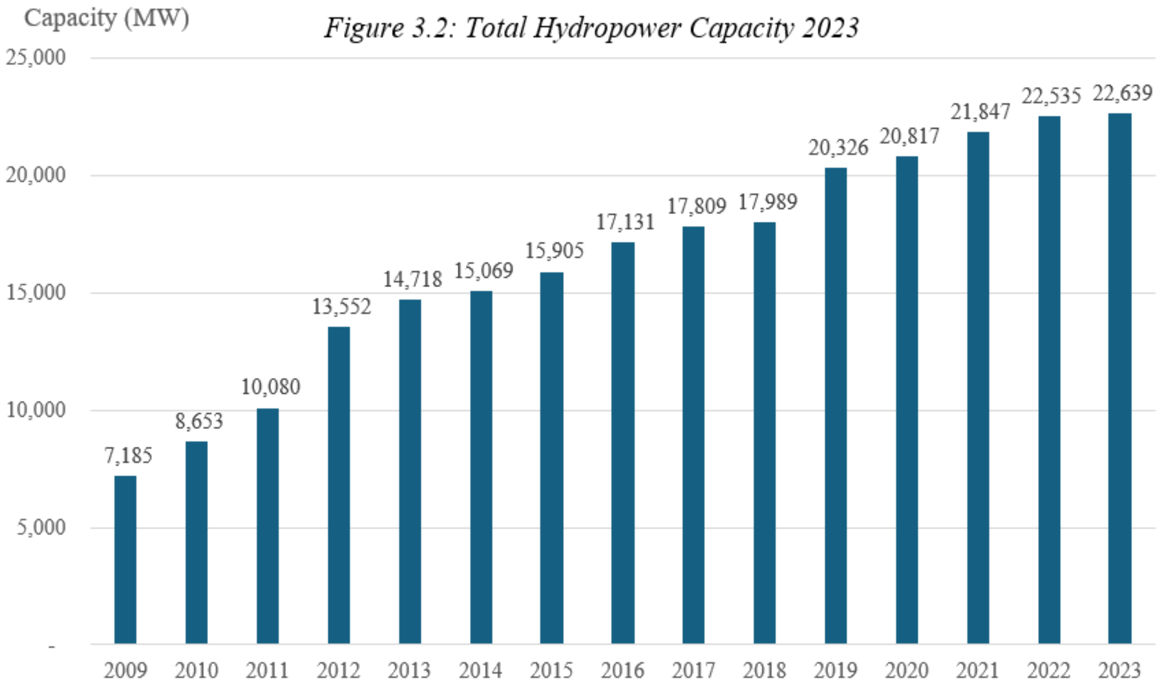
3.3. Potential of renewable energy in electricity generation

3.3.1. Hydropower

Hydropower is one of the largest sources of electricity production in Vietnam. In 2023, hydropower plants contribute 28.89% to the total energy output of the entire industry, with a capacity of approximately 22,639 MW (EVN Annual Report, 2023). As said by Ministry of Industry and Trade (2023), there are 385 hydropower projects in production with a total installed capacity of 18,564MW. In addition, there are 143 hydropower projects under construction with a total installed capacity of 1,848 MW.

Vietnam has a great ability to exploit hydropower for energy supply. In terms of climate, Vietnam is famous for tropical climate, with an average annual rainfall of always high, about 1800 - 2000 mm; a terrain of both mountains and plains; a dense river system; high hills in the West and a long coastline. In the East, there are more than 3,450 river systems. Thereby, Vietnam’s total hydropower capacity can reach 35,000 MW as projected in Power Development Plan 8 (PDP8).

Figure 3.2: Total Hydropower Capacity 2023



Source: Statista.com

Hydropower plants also contribute to flood management, providing water for production and people's needs during the dry season. Moreover, the construction of small power plants does not require large investment capital. More importantly, these projects do not destroy huge areas of forest and agricultural land or affect natural habitats due to the lack of large reservoirs.

According to Decision 500/QD-TTg, the total capacity of hydropower, including small hydroelectricity plants, is expected to reach 29,346 MW by 2030. If the conditions are favorable, the total capacity could achieve 36,016 MW by 2050.

3.3.2. Solar energy

As stated by Dong and Nguyen (2020), compared to fossil fuels, solar energy has numerous advantages in terms of energy production and environmental protection. Vietnam currently has 147 solar power plants in operation with a total capacity of 12,300 MW and 19 plants under construction (Vietnam Energy Outlook Report, 2024). In addition, the country possesses more than 101,000 rooftop solar power systems in households, office buildings, and industrial facilities, leading to a 25-fold increase in solar power generation capacity in just one year.

Regarding geographical feature, Vietnam has a coastline of more than 3,200 km (excluding the Hoang Sa and Truong Sa archipelagos and small islands), which is advantageous in energy resources. Furthermore, Vietnam holds great capacity for solar energy development thanks to its location in the tropical monsoon climate zone, with high solar radiation. According to Statista, the number of hours of sunshine in the Central and Southern provinces is quite substantial, about 2,000-2,600 hours per year. Some areas like Da Nang, Da Lat, Son La, Nha Trang and Vung Tau, sunshine duration attains more than 2,000 hours per year. With such abundant sunshine hours, solar energy exploitation is highly suitable for electricity manufacture.

3.3.3. Wind

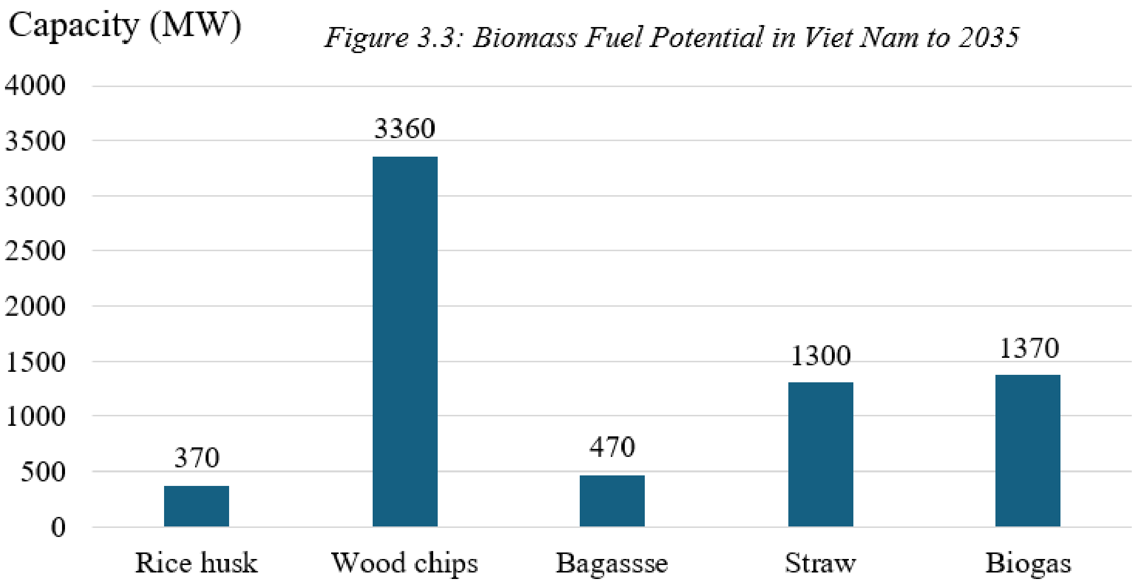
Wind power in Vietnam accounts for more than 39% of the total area of the country in 2024, with an average annual wind speed exceeding 6m/s at a height of 65m, equivalent to a capacity of 512 GW (Xuan, 2021). There are currently 18 wind farms under construction with a total capacity of 812 MW, of which Bac Lieu 3 and Khai Long projects have a capacity of over 100 MW. In addition, Thang Long Wind project has a scale of 3.4 GW, with a total investment of up to 11.9 billion USD and has completed the installation of buoys in July 2021.

Vietnam is also considered to have great potential for offshore wind energy development. The total installed wind power capacity in Vietnam has reached 5,888MW, accounting for about 4% of the total installed capacity of the country (Vietnam Energy Outlook Report, 2024). Power Development Plan (PDP8) noted that wind energy is expected to be one of the main renewable energy sources in Vietnam as the government has set a target of reaching 12,000 MW of total installed wind energy capacity by 2030.

3.3.4. Biomass

As a well-known agricultural country, Vietnam owns immense capability to employ biomass energy. Agricultural waste is mainly concentrated in the Mekong Delta, accounting for approximately 50% of the total agricultural waste of the country and the Red River Delta with 15%. The country has a huge biomass reserve estimated at about 200 million tons of oil equivalent (TOE), accounting for 25% of the country's total renewable energy potential (Vietnam Energy Outlook Report, 2024).

Figure 3.3: Biomass Fuel Potential in Viet Nam to 2035



Source: Thuan Hai Energy Corporation

The main biomass resource is Wood chips with expected potential about 3360 MW in 2035. It is following by Straw and Biogas, which are 1300 and 1370 MW respectively. Besides, Rice husks and Bagasse are the two possible sources for electricity generation, estimated 370 MW and 470 MW correspondingly.

It is suggested that Vietnam can implement 166 projects to exploit biomass energy, with a total capacity of 299 MW, of which the Red River Delta has 23 projects with a capacity of 41 MW and the Mekong Delta has 93 projects with a capacity of 167 MW (Cuong et al., 2021). The biogas potential is estimated at about 10 billion m3/year, which can be collected from landfills, animal manure, agricultural waste, industrial wastewater, etc. Biogas capacity is considerable thanks to the abundant livestock population of more than 30 million, mainly pigs, cows, and water buffalo. Although most of livestock manure has been used for fish farming and fertilizing fields, there is still ability for higher value use through biogas production.

3.4. Recommendation for enhancing the utilization of renewable energy in electricity supply

As stated by Vietnam Energy Outlook Report (2024), energy consumption is increasing rapidly while the growth rate of power plants is not enough to meet the demand. Therefore, the government should attract foreign investment to promote energy development. Based on the above analysis of challenges and opportunities between applying fossil fuels and renewable energy, in accordance with the sustainable development goals, the authors suggest several recommendations as below:

Firstly, it is necessary to develop explicit national standards and rules for renewable energy technology and equipment. Furthermore, there should be an emphasis on strategic collaboration with foreign partners in terms of research and transfer of cutting-edge green energy technology.

Secondly, to maintain energy security, the energy industry and its subsectors should work closely together to create a cohesive and organic system, with electricity planning acting a vital role. The strategic framework would ensure the reliability and efficiency based on energy resources capability and socio-economic environment.

Thirdly, applying flexible operation by enacting appropriate mechanisms to improve the efficiency of coal-fired power plants in synergy with production from renewable energy ones, thereby reducing the overall cost of the system by avoiding the requirement for expensive investments in transmission grid. Moreover, operators' training programs also need to be strengthened to increase the operating flexibility.

Additionally, encourage households to use available energy sources, specifically solar energy. There are mechanisms to support the selling price of solar energy devices for households such as: solar lights, solar water heaters, solar cookers, etc.

Lastly, consider locating hydrogen production sites near renewable energy facilities and utilizing pipeline transportation to save long-term transmission system investments.

4. Discussion and Conclusion

As a global trend, the shift from using fossil fuels to renewable energy is inevitable, and there is no exception for Vietnam. From an economical and environmental perspective, renewable energy programs are more favorable than fossil energy projects. Between 2023 and 2050, it is anticipated that Vietnam's energy mix will be primarily composed of renewable alternatives, including hydropower, solar, wind, and biomass.

Nevertheless, fossil fuels should not be the only source of energy used in the production of electricity. It is necessary to thoroughly evaluate economic aspects to encourage a variety of options. This plan would involve investigation into improving environmentally friendly coal, examining chemical alterations, and developing clean coal technologies to enhance mining and processing approaches.

For further research regarding this topic, it is essential to carefully validate the scenarios for the growth of Vietnamese economy, considering the impact of various factors and expanding the use of forecasting techniques. Without a doubt, risks associated with renewable energy should receive more attention instead of focusing only on their advantages.

In summary, the utilization of renewable energy in electricity supply is a strategic stage to address the issue of sustainable energy development for Vietnam, given the enormous potential demonstrated in this study. This goal must be achieved through the support and collaboration from multiple organizations such as government, businesses, domestic and foreign investors, as well as individuals.

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The Potential of Utilizing Solar Energy in Conjunction with Agricultural Production in Vietnam

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Abstract

The issue of resolving conflicts in agricultural development, particularly in the face of diminishing land resources, has received considerable attention from policymakers in the agricultural and energy sectors. One proposed idea is to combine solar energy and agricultural production as a means to resolve the conflict that arises from the competing demands for land between agriculture and solar electricity. This paper utilizes data collected in Can Tho province and the Green Innovation Development Center (GreenID) to assess the viability of integrating solar energy and agriculture in Vietnam. The findings emphasize Vietnam's suitability for the integration of solar energy with agriculture, citing its advantageous sunlight conditions and ample agricultural land. However, these articles also highlight several challenges in executing the project in Vietnam, such as bureaucratic barriers, financial constraints, and infrastructure requirements. Nevertheless, the overall findings indicate a strong likelihood of attaining success and can be extended to cover the entire nation, thereby making a substantial contribution to the country's continuous efforts towards sustainable development.

Keywords: *Energy economics, renewable energy, solar power generation, land use change, environmental management*

1. Introduction

Vietnam's agriculture has had significant advancements during the last thirty years, resulting in a noteworthy contribution of 18% to the country's GDP and accounting for 15% of the economy's export value. Nevertheless, a significant portion of our population relies on agricultural output. Specifically, 62% of the total population, which exceeds 90 million people, reside in rural areas. Additionally, 47% of the workforce is employed in the agricultural sector. One of the State's interests is to shift the agricultural labor structure to other sectors that offer higher earnings, without compromising the strength of agriculture. Both the State and scientists are interested in the incorporation of solar energy generation into agricultural activities. This technique has the capacity to provide several socio-economic advantages through a versatile land utilization system. The system's socio-economic efficacy has been demonstrated through numerous pilot projects carried out in various nations. The utilization of solar energy combinations in agricultural output has resulted in a notable enhancement in the soil equivalent ratio (LER) in these projects.

Vietnam is currently transitioning to a liberalized energy market model and has implemented a competitive method for pricing power. Renewable energy primarily consists of wind and solar energy. Vietnam has implemented a national policy for the growth of electricity and has established mechanisms to provide support, such as the implementation of electricity price support (FiT) and tax incentives for wind and solar power projects. As per Plan VII (modified) authorized by the Prime Minister in Decision 428/QD-TTg on March 18, 2016, the solar power capacity will amount to just 850 MW in 2020. However, it is projected to increase to 4,000 MW by 2025 and further to 12,000 MW by 2030. Undoubtedly, Vietnam has experienced an unparalleled surge in the adoption of renewable energy sources. The Ministry of Commerce reported that as of mid-2018, they had received a request from the provincial council to add 285 solar power projects to their existing plan. These projects would have a combined capacity of 23,000 MW and would require 27,600 hectares of land. Approximately 70% of these projects are intended to be executed in five provinces located in the southern region, with a particular focus on the DBSCL area. Despite extensive conversations among government officials, experts, and investors over the years, no practical plan has been implemented to integrate agricultural development and solar electricity. By integrating these two crucial sectors, a new opportunity arises to address conflicts regarding land use for renewable energy development and agriculture, particularly in the "food wheels" provinces of the southern region mentioned earlier. This approach aims to prevent the escalation of intense disputes in land utilization within agricultural and rural areas.

In order to fully harness the immense potential of this solar energy source, it is imperative to conduct comprehensive research on how to dismantle policies and address benefits, including the concept of "double benefits". This paper explores the potential of integrating solar modeling with agricultural output in Vietnam and proposes ways to facilitate the advancement of this integrated model.

2. Lessons worldwide about combining solar energy with agriculture and methods used

The initial ideas of this combined model were suggested by experts for a long time, even before the conflict of land resources could be discussed. Founded in Germany in the early 1980s, the concept of combining solar energy has been implemented in a number of countries with hundreds of projects and applications (mostly on a small scale). Recently, more and more large-scale commercial projects have been implemented in a number of countries such as China, Japan, Italy, France. Through their research, the pioneers in the field of solar energy in Germany have come up with the initial theoretical assessment that: with the combination of solar and agricultural energy systems, two-thirds of solar radiation is still helping crops grow while the installation of solar modules is still optimized for power generation. The researchers also showed that the system's solar radiation is almost evenly distributed throughout the day, which helps stimulate crops' growth evenly. The initial conclusion of the study was that the amount of radiation would be sufficient to meet the needs of farming a variety of plants such as black barley, marine wheat, oatmeal, sugar beet, as well as ensuring solar livestock.

With practical evidence that this combination method is highly feasible, weeds can grow very well under these solar installations, and even this plant helps control, contributing to reducing the cost of maintenance of the power system. From the above, the concept of combining solar energy in agricultural production has been formed, attracting the interest of many experts from all over the world, especially in the context of the solar market exploding too fast, leading to conflict in the use of land resources. Therefore, it is understandable that the simple definition of the combined use of solar energy in agricultural production is: simultaneous use of the same area of land for solar and agricultural (including fisheries) production.

It is technically understandable that the core concept of the solar and agricultural combination model is the soil insulation of solar panels. That means, in order for the model to work, the following technical conditions are required: First, typically the combined use system will be installed between 2m and 5m from the ground, as mentioned earlier in the specification section, this installation facilitates mechanized agricultural methods of cultivation (including the use of harvester/tractor) under solar module panels. This approach is aimed at balancing agricultural production while developing solar energy.

Subsequently, for this combination model, the density area (solar power density) of solar module panels is usually lower than that of conventional roof or solar field solar systems. This is to help facilitate the increase in the rate of solar radiation to the ground, to help grow crops and livestock. The distance between these rows of modules is usually determined through the project. This is an important parameter in the installation process because this gap depends on how much coverage the crop needs to grow under the system.

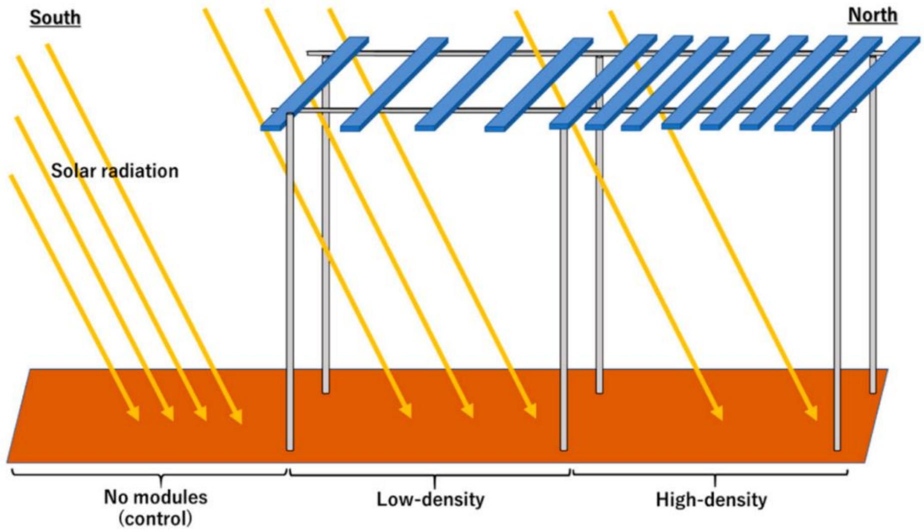

Figure 1: The application of the density of PV panels in agriculture

Source: Author

While the model incorporates elements from both agriculture and solar energy, scientists aim to maximize both in principle. However, in practice, numerous modifications are necessary. In China, over the past two to three years, some extensive integrated model projects have been implemented, wherein agriculture appears to serve merely as a supplementary component. Certain projects fail to achieve the established technical standards, such as achieving elevation from the ground. Instead, they just increase the spacing between the rows of module panels in order to cultivate green vegetables. Nevertheless, the magnitude of these installations can attain a remarkable level, with a capacity exceeding 100 MWp. These solutions prioritize optimization to enhance the production process and maximize earnings from domestic FiT prices.

The Fraunhofer Institute for Solar Energy Research (ISE) in Germany has constructed a solar energy system combined facility on agricultural land that is capable of competing in the market. The primary objective is to optimize the utilization of land resources in Germany, so reducing conflicts in land use and maintaining both food security and energy security. The project will have its maximum impact by integrating solar energy technology into market-competitive agricultural output, together with socio-political innovations such as implementing approval processes at the local level or adapting farm management practices. The study was conducted in a Demeter International conforming natural organic-clean agricultural field located in Heggelbach, in the Lake Constance-Swabia region (Bodensee-Oberschwaben). Advanced production methods, such as the utilization of solar energy combo, have been considered as a means to achieve the ambitious targets established for the region. These aims include increasing the share of renewable energy from 10% in 2013 to 26% by 2022, with solar energy accounting for 15% and becoming the primary source of renewable energy in the region. The productivity of triple-leaf grasses cultivated under the solar energy cylinders experienced a modest loss of only 5.3 percent in comparison to the reference region. However, the yields of potatoes, wheat, and peanuts suffered a significant decline of 18-19 percent. However, this conclusion is still considered feasible. Furthermore, within the initial 12-month period, the solar system generated 1,266 kilowatt-hours of power per installed kilowatt, which is 33% higher than the average power generation value in Germany of 950 kWh/kWp. With an installed capacity of 194 kilowatts, the solar energy battery panels have the ability to provide electricity to 62 households consisting of four individuals each. The electricity generated from the test fields adequately fulfills the farm's daily electrical requirements, and during the summer, the system is nearly capable of satisfying all of the farm's needs. The preliminary findings of the study project indicate that the solar energy combination model led to a significant increase of over 60% in land-use efficiency, as measured by the LER ratio. Following the initial year of observation, the researchers determined that the system was appropriate for implementation. It had a cost comparable to that of a small-scale roof solar system, and it yielded crops with high efficiency that could be sold lucratively in the market.

Similarly, in Asia, other governments have conducted experiments and achieved initial success, with Japan being a prominent example. Japan is considered the birthplace of the notion of utilizing a combination of solar energy, which is also referred to as solar sharing. The agriculture- solar energy project in Chiba province, located near Tokyo, is among the pioneering systems that utilize Japan's new legislation and has received assistance from the FiT pricing mechanism in Japan. The local farmers acknowledge that using solar energy for integrated agricultural production is the most effective approach to revitalize the Japanese farming community. This strategy not only provides avenues for revenue growth but also contributes to fulfilling the energy requirements of the East Asian country. Historically, farmers have had numerous significant challenges, including a decrease in income derived from agricultural activities, a scarcity of individuals willing to inherit family farms, and the necessity for many small-scale farmers to seek additional employment to support their livelihoods.

Here is a description of the pilot and practical projects that have been chosen worldwide, including the key factors and qualities that can be utilized to construct the solar energy model in conjunction with agricultural output in Vietnam.

Table 1: Integrating solar energy with agriculture systems

Project (year of construction)	Energy generation capacity (kWp)	Agriculture system	Other indicators
Germany, Heggelbach, (2015)	194	**Solar energy system is intergrated with agriculture**: Trifolium, Apium graveolens, Solanum tuberosum, Triticum aestivum (first year)	The density of the solar energy system installation is 580 kWp/ha, with a distance of 5m from the ground.
Japan, Shaoshi, Chiba (2017)	1.000	**Integrating solar energy into the production of** soybeans and barley crops.	The solar energy installation density is 313 kWp/ha.
Japan, Kazusatsurumai, Chiba (2011)	34,8	**Integrating solar energy into agricultural production:** Pumpkin, peanut, tomato, sweet potato, taro, eggplant, cucumber, low-growing fruit trees.	The solar energy capacity installation density is 450 kWp/ha, with a distance of 3m from the ground.
Japan, Awajishima (2015)	87	**Integrating solar energy into agricultural production:** Onions and rice	The solar power installation density is 500-600 kWp/ha; the distance from the ground is 3.5m; the distance between columns is 5m.
Japan, Tome and Kami, Miyagi (2017)	1.800/2.200	**Integrating solar energy into agricultural production:** The cultivation of shiitake mushrooms	The solar power installation density is 780/970 kWp/ha, operating under the ESCO model.
Japan, Tsukuba, Ibaraki (2014)	41	**Livestock, poultry:** Chicken, goat	The solar power installation density is 410 kWp/ha, with a distance of 3m from the

Project (year of construction)	Energy generation capacity (kWp)	Agriculture system	Other indicators
			ground and a shading ratio of 33%.
China, Kim Trại, An Huy (2016)	544	**Integrating solar energy into agricultural production:** Rice, soybeans	The solar power installation density is 500 kWp/ha, with a single-axis tracking system.
South Korea, Chungbuk Ochang (2016)	100	**Integrating SOLAR ENERGY into agricultural production:** Rice, cabbage, potatoes, ginseng, soybeans, garlic	The solar power installation density is 435 kWp/ha.
India, Surat, Gujarat (2015)	1.000	**Integrating solar energy into agricultural production: Vegetables**	The solar power installation density is 335 kWp/ha.
Italia, Monticelli (2011)	3.230	**integrating solar energy into agricultural production:** Rice, wheat, soybeans, corn	The solar power installation density is 190 kWp/ha, with a single-axis tracking system.
Croatia, Virovitica-Podravina (2016)	500	**integrating solar energy into agricultural production**: Green vegetables	The solar power installation density is 860 kWp/ha.
France, Réunion (2016)	1.500	**Aquaculture:** Turmeric grass, catfish	The system is integrated with a 9 MWh power storage system to stabilize the island's power grid.
	7.500	**integrating solar energy into agricultural/livestock production:** vegetables, livestock, poultry, bees	
France, Tresserre (2018)	2.100	**integrating solar energy into agricultural/livestock production**: grapes	The solar energy installation has a power density of 420 kWp/ha and is equipped with a monitoring system.

Source: Author

In general, the utilization of solar energy technology and solar heat in greenhouses has proven to be highly advantageous. This combination offers significant benefits such as electricity generation, cost savings, and a reduction in greenhouse gas emissions. Additionally, it has positive socio-economic impacts. For more details, please refer to table 5. The primary challenge associated with this approach pertains to effectively handling certain crops, selecting the most appropriate crops, and implementing semi-transparent solar energy technology to minimize its impact on plant growth.

Based on preliminary scientific observations from tracking systems, the method proves advantageous for some crops by enhancing the amount of light that reaches the plants during the early growth stage, when they are more sensitive to light compared to the later stages of development. Every crop requires specific lighting conditions at each stage of its growth. Ensuring sufficient light dispersion and coverage throughout the entire crop life cycle necessitates comprehensive scientific monitoring. Nevertheless, the solar energy module management approach appears to have a lesser effect on radiation for crop and plant growth compared to the density of module installation.

Table 2: Benefits of integrating solar energy production and agriculture

Benefits for farmers and agricultural production methods	Benefits for provinces and the entire economy
• Additional revenue source from solar power production (selling to the power grid) • Self-generating electricity (self-consumption) and energy saving • Enhancing market opportunities/competition (sustainable production) • Reduce conflicts in land resource utilization (direct pressure from investors or indirect pressure from supportive renewable energy development managers) • Agriculture (vegetables, grains, etc.): Certain crops benefit from increased coverage levels, resulting in higher yields, while the yields of other types of crops may decrease slightly but will be compensated by additional revenue from DM production. • Aquaculture (shrimp/fish farming): Improve water temperature control, minimize water evaporation, inhibit excessive algae growth (where necessary) • Aid in promoting business and enhancing the competitiveness of products (via sustainable production), meeting the needs of sustainable supply chains (especially in export markets).	• Reducing resource conflicts in land use • Increasing income for farmers with the potential for investment in this sector will increase, generating higher tax revenues for provinces and cities • Enhancing the sustainability and competitiveness of the agricultural sector, both in the domestic market and for export. • Reduce CO_2 emissions and harmful emissions from local traditional power plants (such as coal-fired power plants) • Decrease energy consumption in the agriculture/aquaculture sector, benefiting from decentralized power production activities (reducing the need for grid expansion)

Source: Author

3. The potential for developing solar energy and agriculture integration in Vietnam

3.1. The potential of combining solar energy and agriculture in production

Since the implementation of the electricity price system by the Prime Minister in April 2017, there has been a significant increase in the number of registered LPG projects in various provinces of Vietnam. Furthermore, the clustering of solar projects not only brings about beneficial impacts on renewable energy generation and private investment, but also gives rise to problems regarding land utilization, which in turn affects agricultural land resources and people's means of subsistence. Hence, the integration of the LIFE model into agricultural production has been extensively examined as a viable option that yields advantages for all involved parties, guaranteeing the advantages and contributions of local communities, investors, and stakeholders.

Our country, particularly in the Central and Southern areas, has ample sunshine and high levels of radiation intensity, making it very suitable for harnessing solar energy through photovoltaic systems. Since 2002, the Gross Domestic Product (GDP) has been growing at an annual pace of 48 percent, resulting in a doubling of GDP every two years. This rapid growth has significantly contributed to the expansion of the GEO sector. According to the German Development Organization, the Kowloon River has the potential to generate a total of 136,275 MW of solar power. This would amount to an estimated 216.5 billion kWh per year, which is twice the amount of electricity that would be produced by the 14 coal-fired power plants planned for the area, which would generate 108 billion kWh per year. The Mekong delta is widely regarded as the primary region for agriculture and fisheries in the country. Additionally, it is an area with significant potential for renewable energy development in the country.

Currently, Vietnam lacks practical models that have been successfully implemented due to ongoing research. However, there are some solar models combined with small-scale agricultural production that have been put into operation in the provinces of Ninh Thuan and Binh Duong. For instance, the Binh Duong model encompasses a cultivation area of 13 hectares. It employs a method of alternating cultivation of fruit plants in an organic manner, minimizing the use of chemical plant protection agents and instead use organic fertilizers. Additionally, sticky traps or lights are utilized to capture insects, and bio-medicines are employed. The prohibition on the utilization of chemicals contributes to the garden's ability to achieve consistent and high yields. The plants in the garden typically reach maturity between 5 and 6 years of age and are currently in the harvest phase. According to the garden's proprietor, in previous years, a hectare of fruit trees in the garden generated an annual profit of approximately VND 1 billion. The solar cell type, which was installed in Ninh Thuan Province in 2019 on a 1-hectare area, is currently undergoing testing. It is separated into 5 main series, each with a capacity of 1 MWp. The installation of the system requires 20 billion batteries per acre and is positioned around 4 to 5 meters above the ground to accommodate the rearing of large animals like cattle. The project is projected to be financially recouped within a period of 6 to 8 years. Currently, the farm is experimenting with various production models, including sheep breeding, cattle growing, strawberry planting, dragon-bone cultivation, and vegetable seedlings (all grown in aquariums). However, it has not yet determined which model will be the most effective, as it is still in the trial phase. The limitations of these models frequently originate from their small size and lack of experience in developing battery systems, as well as the absence of established frameworks to support and incentivize farmers' outputs, which are currently underdeveloped and require further research and enhancement.

Based on the aforementioned facts and an analysis of past experiences, it is evident that this model has the capacity to be implemented in Vietnam, particularly in the Cuu Long River Delta. This region offers great potential due to its favorable climate conditions, diverse ecosystems, and its status as the agricultural and agricultural science hub of the Mekong delta region. Implementing this model in this area can potentially minimize conflicts in land use and bring about economic and social advantages for both farmers and urban areas.

3.2. Remaining limitations

Investment is a key hurdle in the development of a system that integrates LIFE. In order to get more investment funds from both the public and private sectors for the development of a comprehensive POWER solution, it may be imperative to formulate precise financial models. Given the present median income, farmers may lack the financial means to allocate further funds towards the adoption of technology that utilizes the integration of renewable energy sources. Only a small number of farmers or cooperatives have the financial means to invest in a system that utilizes a variety of energy sources. However, in general, it is crucial to have additional capital investment. At present, Vietnam has regulations in place for solar energy, including the price of electricity supported by feed-in tariffs (FIT). These regulations aim to provide support measures and financial assistance to encourage the growth of underdeveloped markets using the FIT combo model application.

Although previous solar energy development policies have achieved significant advancements, they have not adequately kept pace with the rapid and explosive growth of IT in the past two years, including the rapid technological advancements, increased investment demand, and widespread use of IT. While the origin of this issue may lie in the cognitive background, there is an overlap in the regulations of the texts. This overlap results in the exploitation of regulatory intrusions and the disturbance of investors, thus preventing the achievement of "double development, double benefit" for solar energy and agriculture and fisheries. Regarding the issue of overlapping regulations, there is a specific focus on the concept of "Roof and Roof Electronics". While Resolution No. 55-NQ/TW6 provides a broad and comprehensive framework for promoting the development of rooftop and water-based solar power, the set of specification documents and guidelines that encourage and incentivize investment in Roof and Electronics is specifically tied to the concept of "Roof and Rooftop Electronics". This has resulted in challenges in properly allocating investments and saving funds for investment projects, particularly in sectors such as education, logistics, and agriculture, including fisheries. Implementing the "double-target" cage investment of farms for water (fishing) and soil (agricultural productivity) electronic projects becomes increasingly challenging. This phenomenon is prevalent in An Giang, numerous areas in the Cu Long Delta, and other places. Furthermore, there has been an occurrence of "planning procedures" while determining the magnitude of the project below 1MW. There are no restrictions that permit the utilization of agricultural land and fisheries for the purpose of generating electricity.

The swift advancement of renewable energy sources and the inadequate power grid infrastructure are additional vulnerabilities. The majority of the power lines, ranging from 110 to 500 kV, experience excessive load in various locations, with some areas exceeding 360% of their capacity. Several power line companies (PLCs) are decreasing their transmission capacity by around 60 percent due to the inadequate power generation capacity of PLC facilities, particularly for projects that are not connected to the grid due to transmission infrastructure limitations.

Furthermore, the competitive energy market is still in its early stages and has not developed uniformly. Currently, it is operating a pilot program for "competitive electricity" with an interruption mechanism, but there is no competitive market for electricity sales. As a result, the issue of "electricity price" remains a significant concern, causing stress among people and impacting investment in the overall development of renewable energy, as well as the integration of electricity and agriculture. The absence of inter-sectoral connectedness between power generation and transmission is evident. Additionally, the energy pricing policy is inaccessible and does not fully align with market mechanisms. Furthermore, it is not independent from the social security policy.

4. Solutions on mechanisms and policies for implementing the model

4.1. Certain priorities that need to be addressed

Firstly, it is necessary to clearly define the priorities in the model. The top priority remains the rapid and sustainable development of energy, while still being connected to the protection of the ecological environment, ensuring national security, and achieving progress and social justice, which are of particular importance. These are the central tasks throughout. In addition, it is also necessary to prioritize the immediate resolution of bottlenecks in legal regulations, policy mechanisms, especially in the planning methods and access to solar power potential, which currently still rely on provincial administrative boundaries. Instead, the electricity plans such as Electricity Plan VIII and the plans and strategies of the sector and the nation should be integrated at the regional level, at the very least at the sub-regional level. In addition, it is necessary to invest in the development of electricity transmission infrastructure to be compatible with the overall growth of power sources and specifically solar power. The establishment of an integrated information system for the electricity sector aims to create a transparent market and promote market competition. It is recommended that the government consider providing financial support packages to continuously stimulate the development of the renewable energy sector.

4.2. Enhance the legal framework related to solar energy

As mentioned in the limitations section, one major drawback of this model is its lack of implementation in Vietnam, combined with the recent surge in investment in natural resource exploitation. This has resulted in an excessive number of consecutive policies, mechanisms, and laws, in which basic concepts are continuously duplicated and unclear, causing confusion for investors. Therefore, it is necessary to review and improve the mechanisms, policies, and legal regulations related to solar energy in order to resolve any obstacles to land use and meet the dual objectives of developing solar energy and agriculture. Parallel to that is the resolution of the mentioned shortcomings and the establishment of a mechanism, policies, and laws regarding the efficient management and utilization of resources, as well as capital mobilization... in line with the institutionalization of Resolution 55/NQ-TW and Power Development Plan VIII. Finally, it is necessary to establish and refine national standards and regulations for researching and developing organizational models, coordination mechanisms, policies, and solutions to create virtual resource-based funding in regional economic development.

4.3. Solution for investment and financial issues

To solve the problem of capital capacity and demand of the province as mentioned in the obstacle section, there may be a direction for this issue that is to consider the solution of a third-party investment model, for example, the Energy Service Company (ESCO) model or the Direct Purchase Contract (DPPA). Under these models, a third-party investor (a solar company, a clean technology investor, an ESCP model service provider or a company with a strong potential in the food and beverage sector to create a green supply chain) will join the project, contributing the minimum capital required at a larger level. This third-party investor then has the opportunity to recover the investment by benefiting from the increased revenue rate from the growth energy production or the cost savings incurred in the agricultural/mining production process. However, to do this is not easy, as it requires a well-defined legal framework, so we have to pursue the perfection of the above-mentioned legal solutions.

4.4. Solutions to Environmental Problems in Operations

Besides, according to the research, during the installation process the model is still likely to have effects on the environment, here are a few solutions to minimize the damage to the environment. Minimize the amount of waste and surplus material left over after construction by estimating the exact amount of raw material needed to carry out the project. Then ensure that the collection and disposal of waste is performed well from the time the project is built up to the decommissioning phase in order to minimize the impact on the environment around the project. For solid and environmentally harmful waste, which is difficult to break down and dangerous, it is required to be collected and sorted in order to be properly disposed of. Waste is waste material that can be reused or sold. With gas waste and smoke dust pollution, it is necessary to use fully flammable fuels for vehicles, construction machinery and other engines. Planting greenery in empty areas around the project has both reduced emissions and reduced noise during construction. In addition, it is advisable to invest in new engine machinery that meets certified and certified standards that are not harmful to the environment. Liquid waste is generated during construction, so a drainage system needs to be built around the project area so that wastewater containing pollutants can be collected and transported to wastewater treatment units.

4.5. Proposed price support for people with the output of the combined model

Finally, as mentioned above, although there have been a few small sites that have tested this combination model, but because most of it is just spontaneous, the price of their output is not guaranteed, so in the future, along with the perfection of the model, attention needs to be paid to the development of a new price framework, a new standard assessment scale for the crops, livestock, fisheries that are produced in this new combination method, avoiding the situation that farmers have to invest themselves heavily in new technologies where the product is not enhanced value or is known more widely.

5. Conclusion

Vietnam has achieved significant progress in its economy, particularly in agriculture, which has been a longstanding milestone for the country. Additionally, the development of the renewable energy sector, although relatively new, is also a noteworthy accomplishment. Although Vietnam has undoubtedly achieved notable accomplishments, it is currently confronted with significant obstacles in the realms of agriculture and energy. Regarding agriculture, the sector's productivity is consistently lower than that of the non-agricultural sector due to its significant contribution to the country's GDP. The market prices of certain agricultural commodities exhibit frequent fluctuations, often resulting in supply surpluses due to inadequate planning and limited information exchange among market participants. Consequently, farmers frequently encounter challenges in enhancing productivity and making investments in new technologies. Furthermore, in relation to the energy industry, the increasing number of wind and solar investment initiatives has resulted in a clash between the need for land for these projects and the utilization of agricultural land resources in Southern and Central Vietnam. Vietnam's enormous potential for liquefied natural gas (LNG) is anticipated to draw further investments in gigawatt-scale capacity in the future. However, this growth is also accompanied by an increasing danger of conflicts over land use in the country's agriculturally productive regions.

Thus, the concept of integrating solar energy and agricultural productivity was conceived. This approach aims to prioritize the assessment of conflict risk in the utilization of land resources between the two sectors, and subsequently facilitate the enhancement of farmers' income and livelihoods. The model has been extensively debated and implemented in various locations. The Cuu Long River Delta in Vietnam is regarded as a prime location for conducting experimental and research activities due to its favorable natural conditions. Therefore, the study selected the central city of this region, which has significant potential in both agriculture and the solar energy sector, to analyze and develop model applications.

The results highlight Vietnam's potential for solar energy and agriculture integration, pointing to the country's plenty of agricultural area and favorable sunlight conditions. Nevertheless, despite the promising potential and favorable environmental conditions for implementation, this model encounters numerous challenges in Vietnam. The primary obstacles include policy gaps, complex mechanisms hindering its application, financial constraints, ensuring sufficient output for the combined agricultural products, and inadequate infrastructure for deployment. These issues must be addressed in order to achieve success in implementing this model.

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The Contribution of Wind Power Energy, Fishery and Marine Transportation in the Sustainable Development of Vietnam's Blue Marine Industry

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Abstract

The article explores key issues related to the sustainable development of Vietnam's blue marine industry, focusing on three critical sectors: wind power energy, fisheries, and marine transportation. It presents an ensemble analysis that assesses the current contributions of each sector, utilizing descriptive statistical methods alongside document analysis of both the short-term and long-term plans set forth by the Vietnamese Government and the Communist Party. Based on these findings, the article proposes targeted solutions for relevant governmental and regulatory organizations to enhance sustainability in these industries.

Keywords: *Blue marine industry, fishery, marine transportation, resolution, wind power energy*

1. Introduction

Vietnam, positioned between Southeast Asia as the bridge in sea transportation route, has a 3,260 km-long coastline and thousands of islands with great potential for marine economic development such as aquaculture, mineral exploitation, sea and island tourism, marine transportation services, renewable energy, and marine ecological systems. Based on these favorable conditions, it is necessary to sustainably explore the marine industry as a main part of the development of the country's marine economy. It also plays an important role in industrial development as well as the national economy. This is adapted to the global inevitable development trend of the world. Therefore, the need for research on the sustainable development of the blue marine Vietnamese industry is really necessary.

Recently, in Vietnam, research by Nguyen and Doan (2021) have presented new approaches to the marine economic development, opportunities for developing a blue marine economy and proposed new solutions to building a blue economy. For the other coastal countries, Nourhan and Carmelina (2023) define blue growth as the sustainable industrialization of the ocean for human benefit. It connects different fields of the marine industry such as fishery, transportation, tourism, and coastal ecosystems including coastal protection and carbon storage. For instance, the black sea case study of Bucharest and Romania, where they proposed initiatives for blue growth related mainly to the blue sea industry, pointed out that the marine industry is also an important factor in the development of the blue economy.

Nowadays, most coastal countries prioritize sustainable development of the blue ocean industry, which is considered the inevitable trend in the industry and a competitive advantage of the economy. Vietnam, a developing country with many potential advantages in the coastal ecosystem, also needs to be more aware of the importance of developing the blue marine industry as the main strategy for sustainable economic development.

Resolution No. 23-NQ/TW, dated March 22, 2018, informs the orientations of national industrial development policies to 2030, with a vision to 2045, and defines its aim: "By 2030, Vietnam will finish industrialization and modernization, basically becoming a modern industrial country; and will be of the top 3 leading countries in the ASEAN region in terms of industry; In 2045, Vietnam will become a modern industrialized country."

In the 13th Vietnamese Party Congress, the specified aims were clearly in detail: A developing country with modern industry by 2025; additional high average income by 2030; developed, high-income country by 2045. To successfully achievement these goals, based on clearly understanding the achievements and limitations of science and technology in the process of 35-year promoting industrialization and modernization, along with new thinking about the opportunities and challenges from the fourth Industrial Revolution, from now on, Vietnam needs to actively transition more strongly to a digital economy. This process also requires transforming the growth model to become more and more in-depth, relying heavily on knowledge, innovation, and creativity to have a breakthrough in labor productivity and competitiveness. Vietnam will become a notch in the Indispensably important global value supply chain. During the Congress, the most emphasized highlight policy are promoting national digital transformation; developing the digital economy based on science and technology, utilizing innovative thinking and performance, and proactively grasping promptly and effectively taking advantage of the opportunities of the fourth Industrial Revolution. These policies are associated with the process of international integration to restructure the economy and develop the digital economy and digital society. They are also referred to as a decisive factor in improving productivity, quality, efficiency, and competitiveness as well as contributing to the successful implementation of industrialization and modernization of the country. In 2020, the Vietnamese government issued the 5-year Resolution, namely 26-NQ/CP, for deploying Resolution 36-NQ/TW on sustainable development of the marine economy until 2030 with a vision to 2045. In the 5-year plan, whose important contents related to blue marine economic development, 24 projects and tasks for the period from 2020 to 2025 and 9 projects from 2026 to 2030 are listed to execute. This plan also includes promulgated policies and focuses on the national marine space plan for the period 2021 to 2030 with a vision to 2045 where the main tasks are sustainable exploitation and use of coastal resources.

In this study, we review the sustainable development of the blue marine industry in some countries around the world in terms of the development of wind power, fisheries, and marine transportation. Consequently, we evaluate these factors in Vietnam to answer the research question: What role does development in wind power, fisheries, and marine transportation play in the sustainable development of the blue industry? The recommendations for the Vietnamese development of the blue industry will be given after a statistical analysis of the collected data from the three above fields up to 2022.

2. Methods

2.1. Research methods

To analyze the contribution of wind power energy, fisheries, and marine transportation in the sustainable development of Vietnam's blue marine industry, compositional data was gathered from reliable sources such as the Vietnamese General Statistics Office (GSO: https://www.gso.gov.vn/), World Bank, Vietnam Association of Seafood Exporters and Producers (VASEP), and resolutions from the Vietnamese Government and Communist Party. After processing the data, descriptive statistical methods were applied to summarize the quantitative impact of these sectors. In parallel, document analysis of governmental and party resolutions provided further insights. This combination of statistical analysis and policy review helped identify key features of each sector's impact and supported the development of targeted solutions for sustainable growth in each area.

2.2. Research fields

The selected sectors that significantly impact the sustainable development of Vietnam's blue marine industry are wind power energy, fisheries, and marine transportation. This paper focuses on observing, collecting, and processing data related to the development of these sectors, aiming to evaluate their effectiveness in fostering sustainable green industry in Vietnam. The data evidence demonstrates that developing the blue marine industry helps address environmental pollution limitations and contributes to achieving the Net-zero Carbon goal by enhancing production efficiency, reducing energy consumption, and fostering the creation of green spaces within industrial parks. Proper treatment and recycling of waste in compliance with legal regulations not only mitigate negative environmental impacts but also provide essential input materials for the production process. As fossil fuel sources gradually deplete, researching and utilizing alternative renewable green energy sources become imperative.

Furthermore, adapting the blue marine industry to the Fourth Industrial Revolution and integrating new technologies born from it is crucial. This entails developing industrial park plans with a forward-looking vision to leverage technological potential effectively. Technologies such as the Internet of Things (IoT), robotics, blockchain technology, artificial intelligence (AI), and network security can be integrated into green industrial park development planning to optimize operations and sustainability efforts.

The blue marine industry is inherently linked to blue economic development, which aims to achieve a balance between economic growth and environmental preservation. Clean industries and sustainable resource management are integral components of the green economy. Conversely, the green economy generates new opportunities for clean industries such as renewable energy, green technology, and waste management. Embracing a circular economy approach aims to minimize resource waste and energy consumption while creating new business prospects in recycling, repair, and reuse. Circular economy industries not only generate employment but also mitigate environmental impacts and bolster the sustainability of social systems.

The digital economy presents numerous avenues for industrial advancement. Digital economy industries strive to enhance production and management efficiency, foster job creation, improve connectivity, and cultivate skilled human resources.

In terms of social development, acknowledging social issues during green industry research facilitates the formulation of sustainable and community-oriented solutions, thereby contributing to societal values and environmental preservation. Social trends include establishing conducive employment environments in industrial parks, providing safe, green, and modern living facilities in and around industrial areas, and fostering interaction and collaboration between businesses and local communities. Concentrated industrial zones should be managed and developed into industrial urban areas, with standardized and regulated social infrastructure provisions.

3. Results

3.1. Wind power energy

Vietnam is among the most vulnerable countries to climate change globally, attributed to its extensive coastline, numerous low-lying areas, and hot climate. Consequently, the nation faces significant risks, including sea level rise, floods, droughts, and other extreme weather events, all of which pose threats to socio-economic development and environmental sustainability. The government has proactively developed and implemented various policies to adapt to climate change across multiple sectors, with particular emphasis on the energy sector. The development of wind power energy is a critical aspect in striving for the sustainable development of the blue ocean industry.

In line with global development trends, endeavors to reduce greenhouse gas emissions to combat climate change necessitate the adoption of low-carbon forms of renewable energy. As of October 2020, the International Renewable Energy Agency (IRENA) estimated that renewable energy sources have the capacity to generate 130,000 TWh of electricity annually, more than double the current global electricity consumption demand. IRENA forecasts an annual installation rate for wind and solar power of 109 GW/54 GW by 2030, increasing to 300 GW/200 GW by 2030, and 360 GW/240 GW by 2050. The current contribution of renewable electricity to the total power source stands at 25%, projected to reach 57% by 2030 and 86% by 2050.

Aligned with this development trajectory, Vietnam is also undergoing changes in wind power development. In its proposed plan, Vietnam has pledged to internationally reduce carbon dioxide emissions to zero (Net-zero) by 2050. Onshore, nearshore, and offshore wind power sources are expected to constitute the largest proportion of total power generation by 2045 [4,7]. The development of offshore wind power, in addition to tapping into substantial energy potential, also aligns with the vision of marine economic development.

The task of developing wind power is outlined in Decision 39/2018/QD-TTg issued by the Prime Minister, which amends and supplements certain provisions of Decision 37/2011/QD-TTg concerning policy support for wind power project development in Vietnam. The eighth regulation of Decision 39/2018/QD-TTg mandates that investors commencing construction of wind power projects must submit wind measurement data for a continuous period of at least 12 months. Circular 02/2019/TT-BCT issued by the Ministry of Industry and Trade governs the implementation of wind power project development and provides sample power purchase contracts for wind power projects.

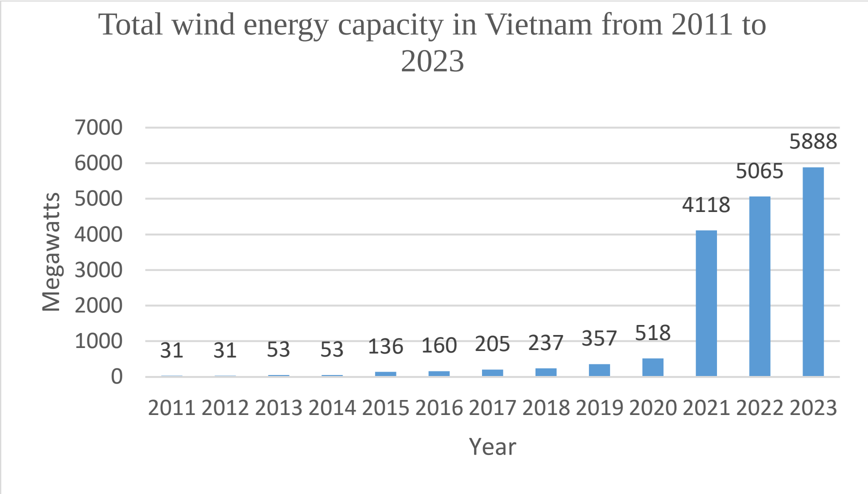

Figure 1: Total wind energy capacity in Vietnam from 2011 to 2023

Source: Statista.com

The chart above shows that the total wind power capacity in Vietnam in the period 2011-2014 was low with no breakthrough development from 31 megawatts to 53 megawatts. From 2015 to 2020, the total wind power capacity increased significantly from 136 megawatts to 518 megawatts. During this period, the total wind power capacity increased significantly compared to the previous period. The period from 2021 to 2023 has had a remarkable change compared to the previous two periods from 4118 megawatts to 5888 megawatts. This is a very impressive result that contributes significantly to the trend of reducing pollution and strengthening national energy security.

Benefitting from a coastline stretching over 3,000 km and abundant wind energy resources, Vietnam possesses significant potential for energy development, estimated at 512GW. The wind energy potential in Vietnam surpasses that of other countries in the region, with more than 39% of Vietnam's total area estimated to have an average annual wind speed greater than 6m/s at an altitude of 65m, equivalent to a capacity of 512GW. Currently, wind power is one of the fastest-growing renewable energy sources in Vietnam. As of July 2023, the total installed capacity of wind power in Vietnam has reached 1,000MW, accounting for approximately 4% of the country's total installed electricity capacity. In the future, wind power is poised to become one of Vietnam's primary renewable energy sources, with a projected total capacity of 6,030MW by 2025 and 10,090MW by 2030.

3.2. Fishery

Recently, the development of Vietnam's fisheries industry is exemplified by the five largest export seafood markets— the United States, China, the EU, Japan, and Korea— which collectively account for nearly 80% of the total seafood export turnover. Among these markets, the EU, United States, China, and Japan present significant potential for Vietnam's seafood exports [5]. According to statistics from the Vietnamese Association of Seafood Exporters and Producers (VASEP), seafood export turnover in 2022 reached 11 billion USD, with shrimp exports totaling 4.3 billion USD, pangasius 2.5 billion USD, and other seafood products 3.2 billion USD (including tuna at 1 billion USD, squid and octopus at 768 million USD). In global export value rankings, Vietnam holds the third position, trailing behind China and Norway. Major export markets for Vietnamese seafood products continue to be the United States, China, Japan, and Korea. In the current context, Vietnam is actively diversifying its seafood exports, with shrimp and shrimp products leading the way in contributing to export value. The aquaculture production sector is increasingly becoming a crucial component of the overall fishery production. It is a state goal to minimize the overexploitation of aquatic resources, both offshore and nearshore, while ensuring adherence to quality standards.

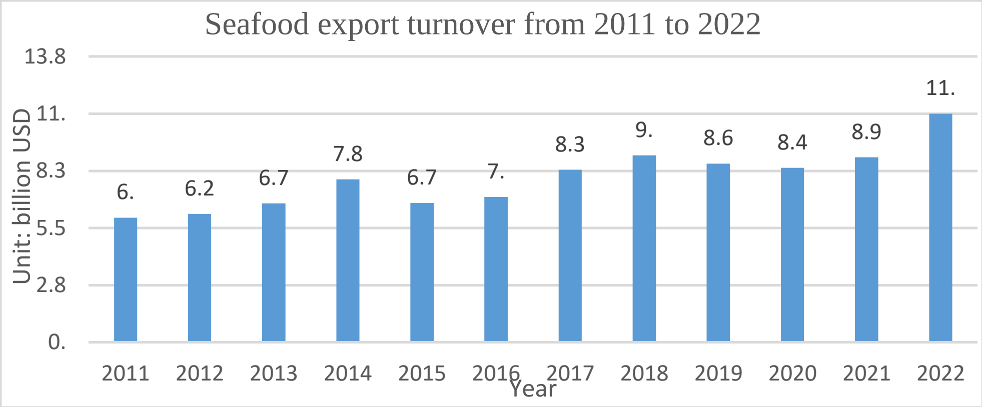

Figure 2: Seafood export turnover during 2011-2022

Source: Chuong Phuong 2023

The change in Vietnam's seafood export turnover during the period 2012-2023, as depicted in Figure 2, reflects an upward trend in exports over the years. Despite the impact of the COVID-19 pandemic, Vietnam managed to maintain its position in seafood exports during the years 2021-2022. Particularly noteworthy is the rapid increase in turnover from 8.9 million USD to 11 million USD in 2022.

In 2023, the fisheries industry has set ambitious targets, including an aquaculture area of 1.3 million hectares, comprising 380,000 hectares for freshwater farming (5,700 hectares for pangasius) and 920,000 hectares for salt and brackish water farming (737,000 hectares for brackish water shrimp). The total aquatic output is expected to reach approximately 8.74 million tons, with fishing output accounting for about 3.58 million tons and aquaculture output for 5.16 million tons. The objective for export turnover is set at around 10 billion USD.

Regarding the annual production volume of Vietnamese seafood, data from 2011 to 2023, as shown in Figure 3, indicates a consistent increase in total seafood revenue. While Vietnam reached 5.9 million tons in 2012, by 2023, this figure is projected to rise to 9.269 million tons.

Figure 3: Production volume of seafood in Vietnam from 2011 to 2023

Source: statista.com

Moreover, in August 2021, the Prime Minister approved the Project to develop the seafood processing industry for the period 2021-2030, encompassing six main points aimed at advancing science and technology, refining institutions, mechanisms, and policies to attract investment, fostering seafood processing development, enhancing quality, and ensuring food safety for processed aquatic products, establishing a system of logistics services and supporting industries to serve the seafood processing sector, nurturing and cultivating human resources, and prioritizing environmental protection and sustainable development to elevate the Vietnamese seafood processing industry into a new phase marked by significant changes in stature, scale, and quality.

Some forecasts suggest that by 2024, seafood production and export in Vietnam may encounter numerous challenges. Factors such as global inflation, which has adversely affected consumption and demand for seafood worldwide, along with geopolitical issues like the Russia-Ukraine conflict and tension in the Red Sea, have disrupted global trade, resulting in increased shipping costs and input prices for seafood farming and processing. Vietnam may also confront obstacles in accessing certain markets. Stagnation in EU exports due to a shortage of human resources and appropriate infrastructure, coupled with the Chinese market's swift recovery, intense competition, and downward pressure on prices, may create a complex scenario for the Vietnamese seafood industry in 2024.

3.3. Marine Transportation

Currently, Vietnam boasts a modern and comprehensive seaport system capable of meeting the economy's demands for importing and exporting goods. Decision 804/QD-TTg, issued on July 8, 2022, announced the list of 34 Vietnamese seaports, comprising 2 special ports, 11 type I seaports, 7 type II seaports, and 14 type III seaports. Furthermore, there has been an increase not only in cargo throughput capacity but also in the capability to accommodate ships with large tonnages. Vietnamese seaports in Hai Phong, Ho Chi Minh City, and Ba Ria-Vung Tau are included among the world's top 50 seaports with the highest cargo throughput. Gateway ports such as Lach Huyen (Hai Phong) and Cai Mep (Ba Ria-Vung Tau) are capable of receiving the largest container ships in the world today, with capacities exceeding 200,000 DWT.

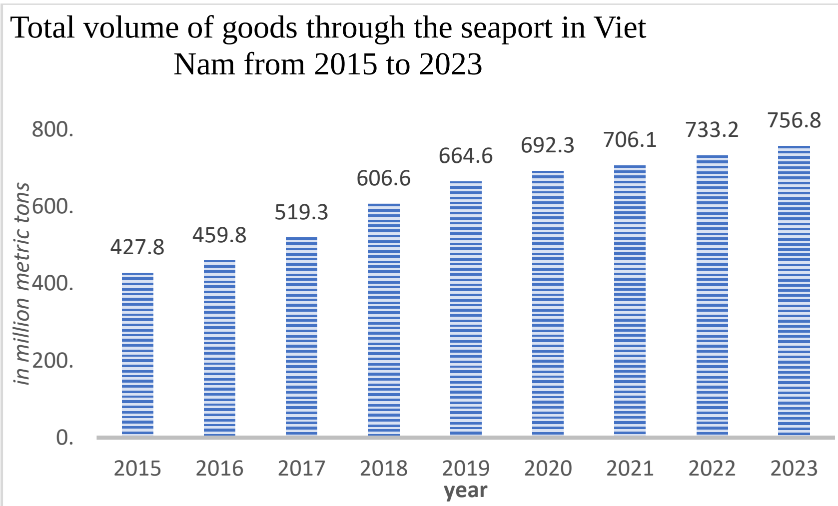

Figure 4: Total volume of goods through the Vietnamese seaport from 2015 to 2023

Source: Vietnamese General Statistics Organization

In the period from 2015 to 2023, the total volume of goods transported through Vietnam's seaports experienced various positive fluctuations. It is estimated that in 2022, this volume will reach about 733.2 million tons, reflecting a 4% increase compared to 2021. Among these, exports are projected to reach 179.07 million tons, down 3%, while imports are estimated at 209.26 million tons, down 2%, and inland transportation is expected to reach 342.79 million tons, indicating a 12% increase compared to 2021. Notably, the volume of container goods through seaports in 2022 is estimated to reach 25.09 million TEUs, marking a 5% increase compared to 2021. High growth in inbound transport routes from China, Japan, Korea, Southeast Asia, and some European destinations, along with rising shipping rates in 2022, has enabled many Vietnamese shipping businesses to achieve record-high revenue and profits.

By 2023, the volume of goods transported through Vietnam's seaports is projected to increase further to 756.8 million tons, reflecting a 5% increase compared to 2022. Export volumes are estimated to reach 179.164 million tons, up 1%, while imports are projected to increase to 221.928 million tons, an 8% rise. Domestic goods transportation is estimated at 353.227 million tons, representing a 4% increase.

Currently, Vietnam's seaport system has attracted investment in infrastructure such as wharves, mooring buoys, and cargo handling equipment. These facilities are fully equipped and scaled to meet the requirements of sea transportation, and they are widely distributed across regions. Based on the stable operation of businesses and proper import and export activities, the demand for domestic and foreign goods transportation has increased significantly compared to previous years. The estimated volume of goods transported by sea in 2022 is expected to reach 108.9 million tons, a 27.9% increase compared to 2021, with goods turnover reaching 235.9 billion tons, marking a 37.7% increase. In the first months of 2023, sea freight transport continues to show positive signs, with transport volume reaching 17.9 million tons, a 17.2% increase over the same period in 2022, and turnover reaching 34.3 billion tons, a 13.7% increase. Although sea freight transport accounts for a small proportion of the overall transport structure, it plays a significant role in goods circulation. In 2022, sea transport accounted for only 5.4% of the total volume of goods transported but contributed to 53.4% of the volume of goods circulated.

Despite achieving many positive results in 2021-2022, the global shipping industry, including Vietnam's, continues to face difficulties in 2023 due to the economic recession. Demand for maritime transport has sharply decreased in many major consumer markets, partly due to reduced purchasing power amid inflation and slow economic recovery. Excess supply from an overabundance of ships exacerbates this situation. The world shipping price index has decreased to the average level of the period from 2011 to 2020. Companies primarily engaged in providing shipping services are expected to face increased competition and significantly lower profit margins compared to the previous period. In 2023, reports from the United Nations Conference on Trade and Development (UNCTAD) indicate that Vietnam's shipping fleet has improved its performance, ranking third in Southeast Asia and 22nd globally.

4. Discussion and Conclusion

4.1. Discussion

Wind power energy

The analysis results above highlight that developing wind power stands as a breakthrough solution to ensure national energy security, decrease reliance on imported fuel, and mitigate emissions of pollutants and greenhouse gases, particularly towards sustainable development in the green industry. This sector generates numerous job opportunities, fosters local economic and social progress, and enhances the livelihoods of local communities throughout various phases, from preparation to decommissioning. Furthermore, it offers high-quality job prospects for the domestic workforce during the developmental stages. Enhanced underwater foundation structures for offshore wind turbines can function as artificial reefs, attracting diverse plankton and small fish species, consequently influencing the marine food chain positively. Gradually, the marine ecosystem will restore itself and evolve into a nature reserve.

Fishery

The consistent positive trend in total seafood export output over the years reaffirms seafood's status as one of Vietnam's key export commodities. Therefore, vigorous development of the seafood processing industry will contribute significantly to the sustainable advancement of the blue ocean industry. Implementing solutions to foster and develop the fisheries industry is imperative. Our recommendations for Fishery include:

- Reorganizing fishery production along the value chain, encompassing raw material production, processing, and consumption across all fields and product categories. Emphasis should be placed on marine exploitation, brackish water shrimp farming, pangasius fish, and bivalve mollusks. Encourage collaboration and risk-sharing between raw material producers and seafood processing enterprises. Additionally, reorganize, consolidate, build, and develop the mechanical engineering, shipbuilding and repair, and fishing gear production sectors in key fishing areas.

- Enhance the effectiveness of trade promotion to solidify and expand traditional markets as well as major markets (EU, Japan, US), and explore opportunities in Eastern European, Middle Eastern, and Central markets, including China and Korea. Moreover, develop and expand the domestic market to cater to tourism, urban areas, and large residential areas.

- Invest in training and developing aquatic human resources tailored to production demands. Focus on training highly specialized, scientific, and managerial personnel; socialize fishery labor training according to market requirements. Implement priority policies for training human resources in marine fisheries activities, particularly scientific personnel in resource management, exploitation, mechanics, and fishing vessel registration. Foster a link between human resource development, population management, and the construction of coastal fishing villages.
- Simultaneously, prioritize environmental protection and the regeneration and development of aquatic resources. Encourage the adoption of new, advanced, and eco-friendly technologies to minimize and manage environmental pollution during the seafood industry's production processes.

Marine Transportation

The summary of goods volume through seaports underscores that developing the shipping industry is a positive and effective direction for Vietnam's sustainable development in the blue ocean industry. Key recommendations in this field include:

- Synchronize the legal system related to sea customs clearance with the country's current economic development context, accounting for climate change and the ongoing Fourth Industrial Revolution, which is significantly impacting other countries worldwide.
- Invest in infrastructure to support the marine transportation system, subsequently facilitating more flexible and effective development of marine transportation.
- Foster deep and extensive international cooperation, particularly concerning marine economic matters. Formulate policies that align with integration and cooperation processes with other nations to effectively develop the marine industry and reap numerous benefits.

4.2. Conclusion

In conclusion, based on the advancements in wind power energy, fisheries, and marine transportation, Vietnam is aligning itself with global trends towards the sustainable development of the blue marine industry. The numerical statistical analysis further confirms that sustainable development within the blue marine industry is intertwined across various sectors. This study has highlighted the significance of advancements in wind power, fisheries, and marine transportation as crucial factors contributing to Vietnam's current sustainable development within the blue marine industry.

The development of the blue ocean industry necessitates addressing environmental pollution concerns, particularly in the marine environment, which stands as an urgent global issue. It is imperative to exploit and develop fisheries in a responsible manner to harness the marine economic potential while simultaneously preserving the marine ecosystem. Additionally, maritime transportation requires specific regulations and legal frameworks tailored to Vietnam's current socio-economic landscape. These measures are essential for steering Vietnam towards a sustainable and prosperous future within the blue marine industry.

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Biodiversity Offsets for Sustainable Development: Theoretical Framework and Applicability in Vietnam

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Abstract

According to the Convention on Biological Diversity (CBD) Secretariat (2017), conservation and sustainable use of biodiversity contribute directly to or support the achievement of 12 of the 17 SDGs (1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, and 15); the five remaining SDGs are linked to biodiversity to some degree. The degradation of biodiversity poses systemic economic and environmental risks, requiring innovative conservation mechanisms. Over the decades, there have been many studies and initiatives on different financial mechanisms to create sustainable funding sources for biodiversity conservation, including biodiversity offsets (or bio-offset). The paper evaluates how bio-offset mechanisms could be implemented within Vietnam's regulatory and institutional frameworks using qualitative methods, including a review of existing literature, policy analysis, and case studies from countries with operational biodiversity credit markets. The paper suggests that while biodiversity offsets offer promising financial and ecological benefits, Vietnam's current legislative and technical frameworks are insufficient for immediate adoption. Recommendations focus on improving its institutional framework for the application of the bio-offset compensation mechanism in Vietnam after the year 2030.

Keywords: *Biodiversity, Biodiversity conservation, Biodiversity credits*

1. Introduction

Biodiversity represents the variety of life on Earth, including the full range of ecosystems, species, and genes. Natural ecosystems and wild species sustain human society in numerous and often irreplaceable ways. Nonetheless, much of our planet's biodiversity is today under severe pressure from human activities, with alarmingly high numbers of animal and plant species now at risk of extinction. Worldwide, the single greatest threat today to biodiversity is the rapid loss and degradation of many natural habitats. Other major threats include the human-facilitated spread of non-native invasive species, along with the overharvesting and incidental take of many native species; there are also the newly emerging threats of human-induced climate change and ocean acidification. Biodiversity loss is today widely regarded as a global environmental crisis because of its scale and irreversibility—species extinctions are forever. Alike to climate change, the economic and financial risks associated with biodiversity loss are systemic. Severe degradation of nature has the potential to undermine the achievement of the Sustainable Development Goals (SDGs). According to the Convention on Biological Diversity (CBD) Secretariat, conservation and sustainable use of biodiversity contribute directly to or support the achievement of 12 of the 17 SDGs (1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, and 15); the five remaining SDGs are linked to biodiversity to some degree (CBD Secretariat, 2017).

Biodiversity conservation efforts to date have achieved a great deal to help secure the continued functioning of many threatened ecosystems and the survival of numerous species. However, these efforts have often not been sufficient; numerous species and ecosystems remain at risk. Many natural ecosystems are under severe pressure from agricultural expansion, extractive industries, and large-scale infrastructure projects. The world's human population is still increasing, as are the aspirations of most people for improved well-being, including greater material wealth. Making the transition to a more densely populated and prosperous world, while adequately conserving biodiversity, is an enormous challenge, requiring the effective application of a wide range of tools. One type of conservation tool which—when appropriately used—could help to scale-up needed conservation efforts is biodiversity offsets. Under the right circumstances, biodiversity offsets can (i) improve the conservation outcomes from large-scale development projects and (ii) provide much-needed funding for protected areas and similar conservation efforts.

This paper aims to introduce an innovative financing mechanism for biodiversity conservation, which has been successfully tested worldwide, core principles and needs for legal support for the mechanism to be applicable in practice. Based on that framework, the paper assesses readiness for application in Vietnam's institutional arrangements. It provides recommendations for introducing the bio-offsets mechanism as a new and valuable funding sources for biodiversity conservation in the country.

2. Theoretical Framework

Definition and Intended Outcomes of bio-offsets. According to the Business and Biodiversity Offsets Program (BBOP), biodiversity offsets or bio-offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development and persisting after appropriate avoidance, minimization, and restoration measures have been taken" (BBOP, 2009). This definition is similar to that used by other conservation and development organizations that focus on offsets, including the International Finance Corporation (IFC) Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6), International Council on Mining and Metals (ICMM), and World Conservation Union (IUCN). Simply speaking, bio-offsets can be regarded as additional conservation activities intended to compensate for the otherwise inevitable damage to species or ecosystems resulting from a development project.

The goal of bio-offsets is to achieve **No Net Loss** and preferably a **Net Gain** of biodiversity on the ground (or in the water), in comparison to the baseline situation before the original project is implemented. Theoretically, bio-offsets are designed as a mechanism to ameliorate the negative environmental impacts of land acquisition for urban, infrastructure, agricultural or mining development (projects). Accordingly, this mechanism sets the goal of improving the biodiversity of an area (being) compensated without losing biodiversity values. Therefore, bio-offsets can be implemented in many different forms through the protection and management of biodiversity values in one area in exchange for impacts on biodiversity values in another area, or through the restoration of habitats/environments on previously cleared land or enhancing the habitat quality of an area with conservation potential or expanding (conserving) a new potential area (Lai & Nguyen, 2023).

Bio-offsets can include securing or setting aside land or water areas for conservation, enhanced management of habitats or species, and other defined activities. They can be used to (1) create, expand or buffer existing protected areas; (2) enhance, link or restore habitats and (3) protect or manage species of conservation interest (either within a designated conservation area or more broadly across the landscape or aquatic habitat where the species occurs). Irrespective of the specific focus of the offset activities, measurable (or at least verifiable) conservation outcomes should be achieved. Bio-offsets can be implemented in terrestrial, freshwater, or marine ecosystems, although to date most have been land-based.

Bio-offsets consist of restoration and Restoration and Preservation Offsets. *Restoration offsets* involve deliberate actions to restore an ecosystem, habitat, or species population (outside the footprint of the original development project) and thereby improve its biodiversity conservation status or value. An example might be improving the ecological functioning and biodiversity value of a wetland by increasing its available water supply. *Preservation offsets* (aka protection or averted loss offsets) involve intentionally protecting an ecosystem, habitat, or species population (outside the original project's footprint) that is already in good condition or otherwise of high biodiversity value, but that lacks sufficient legal or on-the-ground protection. Preservation offsets assume that the designated offset area (or species of concern) would eventually be diminished, degraded, or lost if it were not explicitly protected through the conservation support provided by the bio-offset.

Bio-offsets differ from other kinds of conservation activities in two main ways: Firstly, it links to damage from another project. Unlike "free-standing" conservation projects, bio-offsets are explicitly linked to one or more development projects that are causing some loss of biodiversity, such as the elimination or degradation of a patch of natural habitat or a population reduction in one or more species of conservation interest. Secondly, it focuses on the No Net Loss or Net Gain principle. Bio-offsets are normally expected to fully compensate for specified adverse residual impacts (to the level of No Net Loss or preferably Net Gain) in a way that is measurable or verifiable, long-term, and additional to any other (ongoing or planned) conservation measures. As such, offsets are a more structured and consistent approach to mitigating biodiversity loss than certain other approaches, such as (i) habitat set-asides (where a portion of the project area is intentionally left undeveloped) to reduce the residual adverse impact on biodiversity or (ii) various conservation enhancement activities that might be of great value but are not set up to compensate for the specific adverse impacts resulting from the original development project.

Benefits and constraints of bio-offsets. Conserving biodiversity also typically means conserving ecosystem services, which are the benefits that people derive from ecosystems. Ecosystem services are often of tremendous— and under-appreciated—value in sustaining livelihoods and human well-being. Ecosystem services can be grouped into four types (PS6, 2012): (i) Provisioning services, which are the products people obtain from ecosystems such as fish and other wild foods, fresh water, wood and other fibers, and medicinal plants; (ii) regulating services, such as water purification, protection from floods and other natural hazards, erosion control, and climate regulation; (iii) cultural services, including sacred sites, recreation, and aesthetic enjoyment; and (iv) supporting services, which are the natural processes that maintain the other services and include pollination, soil formation, nutrient cycling, and primary production.

Bio-offsets are focused on the conservation of species and ecosystems, in an area that is typically separate and distinct from the original project area. Benefits of bio-offsets are: (i) promoting intensive development of biodiversity conservation activities; (ii) more effective conservation efforts: not only restoring biodiversity to pre-project levels but also making additionality - enriching biodiversity; (iii) using conservation funds more effectively: Offsets help focus resources to support biodiversity conservation and ecosystem services where needed; (iv) creating value for undeveloped areas; (v) monetarizing the value of gained or lost habitats; (vi) optimizing benefits from conservation ; and (vii) increasing commercial benefits for companies: today, to be environmentally responsible, an enterprise should not only comply with environmental regulations, exercise its corporate social responsibilities but also make its image and brands highly appreciated by consumers. Therefore, implementing bio-offsets will create additional funds for conservation outcomes from the private sector, helping the government achieve development goals on biodiversity conservation as set in national sustainable development strategies and action plans (Maguire & To, 2010).

Nonetheless, bio-offsets are not an appropriate tool to offset partial losses of certain ecosystem services. Depending on their location, bio-offsets should help maintain ecosystem services similar to those in the original project area. However, many site-specific ecosystem services cannot be maintained or fully replaced by bio-offsets at another site, due to a variety of factors (such as physical distance from the original project site or more stringent resource use restrictions in the area being offset). For this reason, the loss of ecosystem services themselves often needs to be mitigated through measures other than bio-offsets. For example, an irrigation, mining, or other development project that cuts off a community's access to local freshwater may need to assist the affected community in developing an alternative water supply, rather than preserving a similar ecosystem through bio-offsets.

Therefore, the use of bio-offsets should only be considered a last resort after other measures to mitigate biodiversity impacts have been considered. Development project planners should (1) first seek to avoid damaging any biodiversity; (2) then seek to minimize any such damage; (3) then consider how to restore sites or species populations damaged by the project; and (4) then—if adverse biodiversity impacts still remain—compensate through specific actions (not merely cash) comprising a bio-offset. The mitigation hierarchy is illustrated in Figure 1. In short, the optimal approach emphasis on designing out risk to the maximum extent possible (through avoidance and minimization), and only then implementing corrective measures as needed (through restoration and then compensation, including offsets).

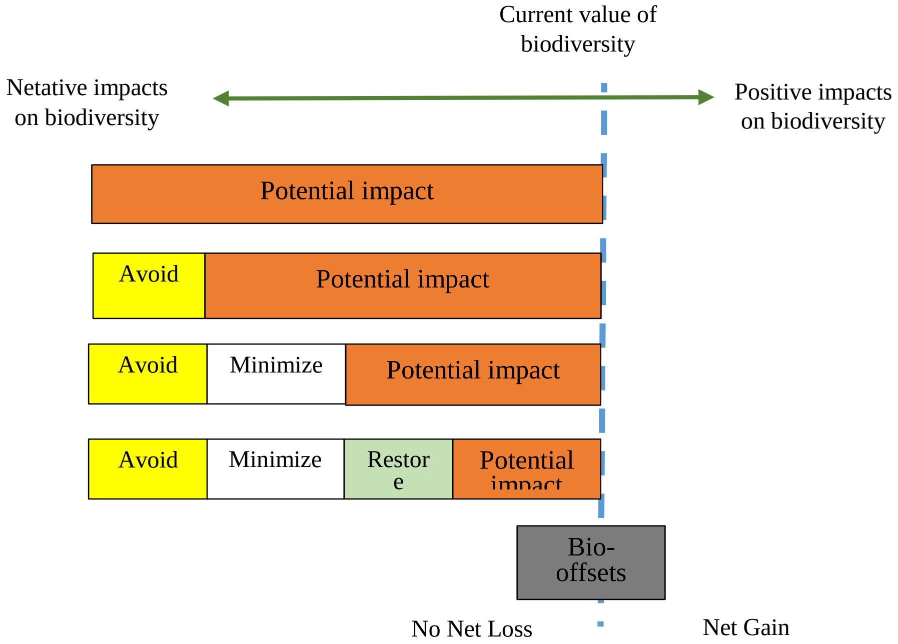

Figure 1: The biodiversity loss mitigation hierarchy of development projects

Source: World Bank, 2016

Core principles for bio-offsets. BBOP (2009) has assessed, identified and synthesized the guiding principles for establishing a framework for designing and implementing bio-offset plans and verifying achieved results. Accordingly, bio-offsets need to comply with the following core principles:

- *Strictly follow the mitigation hierarchy:* a bio-offset plan is a commitment to offset residual adverse impacts on biodiversity identified after all possible on-site avoidance, minimization and restoration measures have been undertaken in accordance with the mitigation hierarchy in Figure.
- *Limit what can be offset:* clearly identify residual impacts that cannot be compensated for by bio-offsets measures because of the irreplaceability or vulnerability of the affected biodiversity.
- *Landscape/habitat-based:* ensure that the bio-offset plan is designed and implemented in the certain context of the landscape and habitats to achieve expected measurable conservation outcomes, taking into account available information on the biological, social and cultural values of biodiversity and supporting an ecosystem approach.
- *No Net Loss/No Net Loss:* bio-offsets should be designed and implemented to achieve in-situ conservation outcomes, which are reasonably measurable, in the direction of no net loss or net gain.
- *Generate additionality to conservation outcomes:* offsets should bring similar or greater expected outcomes than would be achieved without offsets. Ensure that the design and implementation of bio-offset plans do not import harmful activities to biodiversity into other sites.
- *Ensure [full and effective] participation* of stakeholders in all stages of the decision-making process for bio-offset implementation, including assessment, selection, design, implementation and monitoring.
- *Ensure fairness/equitable rights (benefits) and responsibilities* among stakeholders in the design and implementation of bio-offsets, including risks and rewards associated with the project, respect for legal agreements and customary laws, and the recognized rights of ethnic minorities and local communities.
- *Sustain long-term results* based on an adaption management approach in combination with effective monitoring and evaluation, aiming to maintain achieved results at least in the entire project life cycle, and preferably, for the longer term.
- *Ensure openness and transparency* throughout the design, implementation, and communication of bio-offset implementation plans.
- *Respect/apply scientific and traditional knowledge:* must be clearly demonstrated in the documentation and communication of offset implementation.

3. Results

3.1. International experiences in the adoption of bio–offset measures

Bio-offsets model in New South Wales (NSW), Australia. According to Lai & Nguyen (2023), this model was first introduced in July 2018 with the goal of "adopting market-based incentives that both encourage conservation actions and limits and prevents harmful activity on biodiversity". The offset mechanism was formed based on the rule of the NSW State Act that "any individual or organization implementing a project that creates impacts or clears 0.5 ha (5,000 m^2) of vegetation (will) be required to make offsets". To get required levels of offsets, project developers must buy biodiversity credits. Evidence shows that in the period 2015-2019 in NSW, bio-credits worth up to USD 266 million were transferred. Thus, this NSW bio-offsets has been linked to the market for biodiversity credits. The existing products, buyers, sellers, brokers through intermediary financial instruments are described as follows:

Biodiversity credit: It is a conservation endorsement or certificate to capitalize biodiversity conservation efforts. Biodiversity credit is used to measure the unavoidable impacts on biodiversity from the development or expansion of a development area; the projected improvement in biodiversity status achieved at a managed site. Biodiversity credit represents the expected level of biodiversity improvement, which is the result of the protection and management of a conservation area registered by the landowner... There are two types of biodiversity credits: ecosystem credit and species credit. While the former measures the value of threatened ecosystems, habitats of threatened species or species that are predicted to be threatened such as the case with plant communities, the latter is applied to all other threatened species found in the area without a reliable prediction of threaten occurrence in the identified ecological communities in the development area.

Biodiversity conservation agreement: It is a voluntary agreement between a biodiversity conservation organization and a protected area manager to improve the biodiversity value in that protected area. This agreement allows the protected area manager to create biodiversity credits, which can be transferred to the conservation organization or to organizations or individuals being accountable for offsets.

Bio-offset Fund: The Fund is managed by biodiversity conservation organizations. Organizations and individuals accountable for bio-offsets can deposit on the fund, and the biodiversity conservation organizations can search for and purchase suitable credits on their behalf and help them fulfil their bio-offsets obligations.

Other bio-offset models. WB (2016) provides a nice summary matrix on typical bio-offset models experienced in the world, which has been repeated in Table 1. It shows that around the world, various successful initiatives of market-based bio-offset measures have been implemented. As shown in Table 1, the economic tool of "biodiversity credit" is exchanged on the market between buyers and sellers, and at the same time, a biodiversity bank is established to promote the biodiversity credit market. Given high biodiversity value but limited financial capacity, Vietnam should promote research, pilot different models to provide a base for improving its institutional corridors for putting bio-offset mechanism into practice. This can be seen as a potential financing source for biodiversity conservation to reverse trends of biodiversity losses caused by socio-economic development activities.

Table 1: Different types of National or sub-national biodiversity offset frameworks

	1. Compensation Funds	**2. Mitigation Banking**	**3. Developer Implements under Government Framework**	**4. Government Implements with Developer Support**
A. Type of Offsets System	• Compensation funds provide a mechanism whereby project developers are required to pay a fixed fee or a percentage of total	• Mitigation banking (aka conservation banking) typically involves buying credits from third parties who have already restored or own sites in the	Project developer (whether private firm or public agency) is responsible for implementing the offset, although the location and	Government implements the offset, typically as part of a protected area strategy, but the costs are paid by the project developer (private

	1. Compensation Funds	**2. Mitigation Banking**	**3. Developer Implements under Government Framework**	**4. Government Implements with Developer Support**
	project cost, instead of conducting project-specific mitigation or buying conservation credits. They are sometimes referred to as in-lieu payment systems. • Funds either directly go towards compensation for project-caused biodiversity losses, or they support more indirect biodiversity-related projects such as funding protected areas management or research.	same region to offset the impacts of a project. • Conservation area habitat "banks" are typically located on private (individual or community) lands. The value of habitat credits fluctuates based on economic factors, land values, competition, and market demand. • Often there are "brokers" who connect people who want credits with people who are selling credits.	approach is decided by a government environmental agency, which also provides guidance on offset design.	or public sector). The amount to be paid by the developer is based on the area and quality of the habitat to be affected by the proposed project. Offset sites are normally expected to be similar to, or (ideally) better than, the areas lost to the project.
B. Conditions where Approach may be Useful	• Can be used in situations of uncertain land tenure, since the funds are typically applied to protected areas. • Require a reasonable level of capacity within regulatory and enforcement agencies, but less than for conservation or mitigation banking.	• Works well in situations where a lot of land is under private ownership with well-established tenure. • Requires a well-developed market infrastructure and is dependent on a high level of capacity within regulatory and enforcement agencies.	• Requires good data on the location and quality of different habitats, including potential offset sites. • Requires reasonable level of capacity within regulatory and enforcement agencies, especially if project-specific offsets are part of the mix.	• Can be used in situations of uncertain land tenure, since the funds are typically applied to protected areas. • Suited to countries seeking to significantly expand the area and/or increase the funding for their protected areas network.
C. Some Examples	• The Environmental Compensation Fund in Brazil was established under the National Protected Areas System Law (Federal Law 9985/2000). It has channelled funds from large infrastructure projects to	• In the United States, mitigation banking is used nationwide to promote "no net loss" of wetlands protected under the Clean Water Act. In Australia, the State of Victoria's Bush Broker program works by identifying	• In Colombia, offsets are required for mining, oil and gas, other energy projects, new ports, infrastructure and new international airports (Resolution 1517 of 2012, Article	• Biodiversity Offsets Roadmap for Liberia proposes that large mining companies be encouraged or required to support offsets within proposed protected areas, enabling them to

	1. Compensation Funds	2. Mitigation Banking	3. Developer Implements under Government Framework	4. Government Implements with Developer Support
	protected areas and other conservation initiatives. For example, the Bolivia-Brazil Gas Pipeline (GASBOL) Project channelled the required 0.5% of project investment costs to on-the-ground strengthening activities in 12 Brazilian protected areas within the general vicinity of the pipeline route.	landowners willing to preserve and manage native vegetation. A Bush Broker official assesses the potential offset site using a Habitat Hectares methodology and determines the number and type of credits available for sale to developers.	2). They are implemented by the private sector but the National Environmental License Authority (ANLA) identifies the site in accordance with the regulation.	become part of the formal protected areas network. • Biodiversity Offsets Roadmap for Mozambique proposes a system in which project developers would support offsets that strengthen parts of the spatially extensive yet severely underfunded protected areas network.
D. Advantages	• Compensation funds are fairly straightforward to implement, compared with either conservation or national no-net-loss frameworks. • Low burden to developers, as simple payments are made proportional to project size.	• Developers (private firms or public works agencies) need not spend time and effort to locate offset sites, since this responsibility is vested in a third party (such as Bush Broker). • Offset sites are identified, protected, and sometimes restored before the development project's adverse impacts occur; thus, there is often no time lag between biodiversity losses and gains. • A single large site can provide compensatory mitigation for impacts from two or more projects. • May reduce the time needed for the development	• Approaches can be designed to embody the offset principles of No Net Loss or Net Gain and like-for-like or trading-up. • Offset sites may be identified, protected, or restored before the project's adverse impacts occur, in which case there is no time lag between biodiversity losses and gains. • A single large site can provide compensatory mitigation for impacts from several projects. • May reduce the time needed for the development project to obtain environmental permits. • Facilitates a strategic	• Developers (private firms or public works agencies) need not spend time and effort to locate offset sites, since this responsibility is vested in the government. • Offset sites are identified and protected with developer support, but before the original project's adverse impacts occur; thus, there is no time lag between biodiversity losses and gains. • A single large site can provide compensatory mitigation for impacts from several projects. • Facilitates a strategic

	1. Compensation Funds	2. Mitigation Banking	3. Developer Implements under Government Framework	4. Government Implements with Developer Support
		project to obtain environmental permits. • Developers with limited capacity (such as smaller firms) can easily participate.	approach to biodiversity conservation at a landscape level, since offset sites are pre-selected.	approach to biodiversity conservation at a landscape level, since offset sites are pre-selected.
E. Disadvantages	• Strictly speaking, compensation funds are not real biodiversity offsets because the conservation actions supported do not necessarily involve (i) the same ecosystems or species that were harmed under the original project or (ii) "trading up" to an ecosystem of higher conservation priority. • In the absence of adequate safeguards for project permitting, a simple mechanism for making compensation payments could facilitate, rather than deter, projects that convert natural habitats. • In the absence of clear criteria and procedures for how the funds collected are to be spent as intended on biodiversity conservation, the money could accumulate unused in a special account and/or be diverted to unrelated uses. • If the amount to be paid by the (private or public sector)	• An effective mitigation banking system normally requires secure land tenure, a well-functioning legal system, and adequate governmental regulatory oversight; it may thus be best suited for more highly developed countries. • Over time, landowners might not adequately manage their designated offset land from a biodiversity standpoint, due to high recurrent costs, insufficient commitment to conservation, etc. • The potential supply of high conservation value offset sites might be limited, particularly if many landowners are reluctant to commit to permanent land or water use restrictions. • Some mitigation banks rely on restoration offsets (as opposed to averted loss offsets), which can be high risk, not cost-effective, or	• Project developer still needs to implement the offset and may lack the requisite capacity or commitment. • Finding suitable offset sites might be difficult, especially to obtain a like-for-like ecosystem match.	• Offsets may be located far away from the original development project; in such cases, stake holders might perceive that the original project's impact and the corresponding offset are not really connected. • Extractive industry and other private firms might be reluctant to support government-implemented offsets, fearing the potential diversion of their funds to other uses.

	1. Compensation Funds	2. Mitigation Banking	3. Developer Implements under Government Framework	4. Government Implements with Developer Support
	developer is a fixed fee or based on total project costs (rather than specific project impacts), it does not pro vide an incentive for the developer to reduce biodiversity damage through mitigation hierarchy. • Compensation funds can be perceived as just another tax, making them politically vulnerable to reduction or elimination.	impossible for some habitats.		

Source: World Bank, 2016 (Table 8.1)

3.2. Institutional readiness for applying biodiversity offsets in Vietnam

Bio-offsets has been identified as a new factor in Vietnam's National Strategy on Biodiversity 2030, or NBSAP 2030 (Government, 2022b), which requires (i) "developing regulations and guidelines for bio-offsets" as a vehicle for implementing the core task on "expanding and improving managerial effectiveness of natural heritage systems, nature reserves and biodiversity corridors", and (ii) "developing, adopting and implementing the bio-offsets mechanism" is a measure for "strictly controlling the conversion of land, forest and water use purposes, unsustainable farming and exploiting practices and environmentally polluting activities". However, the current legal system of Vietnam *does not have specific guidelines on how to exercise bio-offsets mechanism, including an official interpretation of this concept.*

Biodiversity conservation is stipulated in various legal documents, from the Constitution to a series of laws including the Law on Environmental Protection 2014 and 2020, the Law on Biodiversity 2008, the Law on Forest Protection and Development (Forestry), and the Law on Fisheries. Although a separate law on biodiversity has been promulgated, the Law on Biodiversity 2008 (still in effect) does not have any provision on bio-offsets. The Constitution and these laws mainly refer to compensation for environmental damage (including biodiversity losses).

In Vietnam’s legislative hierarchy, law is the legal document that has the highest legal power, just after the Constitution. Law must be promulgated by the National Assembly. Given the generality of many provisions in law, the Government is authorized to issue sub-law regulation (s) – or Decree – to provide a legitimate interpretation of such provisions. By the same procedures, line ministries may be delegated by the Prime Minister to issue a sub-decree – or Circular – to guide the implementation of the law and the decree. In the environmental sphere, the set of law and sub-law regulations governing issues related to the environment, natural resources, biodiversity conservation, climate change and alike are Law on Environmental Protection (in 2014 and its amendment in 2020), Decree 08/2022 and Circular 02/2022, which are discussing in turn. In fact, complying entities, either organizations or individuals, need to get full instructions from this set of regulations to have strong legal backup for implementation of any bio-offset initiative.

Law on Environmental Protection. Bio-offset was first stipulated in Clause 1, Article 35 of the Law on Environmental Protection 2014: "*Natural resources and biodiversity must be investigated and assessed for their current status, regenerative capacity, and economic value to serve as a basis for developing master plan for proper use, determination of exploitation limit, natural resource tax rates, environmental protection fee, environmental restoration deposit, bio-offsets levels and compensations for environmental damage, and other measures on natural resources and environmental protection*". However, the sub-law guiding documents do not include any provision or clause to instruct implementation of bio-offsets.

Next, the amended Law on Environmental Protection 2020 has provisions on bio-offsets, requiring project owners to (i) prepare "Bio-offset plan (if any)" as specified at Clause 1g, Article 32 on the content of the environmental impact assessment report (EIA report); (ii) take responsible for bio-offsets in accordance with relevant provisions of the Law at Clause 3d of Article 32 on Environmental protection conditions, and at Article 40 on "Environmental license".

Government Decree. On January 10, 2022, the Government issued Decree No. 08/2022/ND-CP to specify a number of provisions of the Law on Environmental Protection. At Clause 2, Article 26 of the Decree on "Consultation during conducting EIA", bio-offsets plan in a development project is subject to be publicly consulted if that plan is required for such type of projects. Also, in Clause 1d and Clause 3d of Article 28 on "Main content of the report asking for environmental license" require "Bio-offset plan (if needed)". It is obvious that in both the Law and the Decree, bio-offsets is still treated as a recommending condition rather than a mandatory requirement for project owners. Thus, legal binding of the bio-offsets mechanism is very weak, which is even exacerbated by the ignorance of this issue in the instructional circular.

Instruction circular of Ministry of Natural Resources and Environment (MONRE). MONRE's Circular No. 02/2022/TT-BTNMT dated January 10, 2022, providing specific guidance on implementation of a number of articles of the Law on Environmental Protection still does not have specific instruction on the implementation of bio-offsets.

Thus, currently, bio-offsets have not been implemented in practice and is not feasible in the medium-term (next five years) Vietnam for the following main reasons: (i) There are no detailed legal-binding requirement and guidance (even with the simple interpretation of the concept, including the concept, core implementation principles and conditions) for bio-offset implementation; (ii) Technical difficulties such as the absence of the market for biodiversity credits, the lack of technical guidance for assessing biodiversity values, and methodology for estimating residual loss for bio-offsets.

According to Nguyen (2023), the possibility of adopting bio-offsets in Vietnam depends on whether the current regulations on EIA and granting of environmental permits are supplemented and fully institutionalized and more specific instructions are provided by competent agencies on assessing (current status) biodiversity value of a development project. Also, a clear process and procedures to identify the entity responsible for offsets and estimate the most likely biodiversity loss that cannot be restored by other measures in the mitigation hierarchy (avoidance, minimization, restoration) after the (negative) impacts are scientifically verified and recorded by competent authorities.

Given the fundamental conditions for implementing bio-offset do not exist yet in the current institutional framework in Vietnam, and it takes time for legislative amendments due to time-consuming procedures and interaction among relevant regulations, it is naive to expect that a more enabling legal environment can be established in medium term to accelerate application of any bio-offsets initiatives. However, that is the task that amendment of the Law on Biodiversity should take into account: learning from international best practices on how to set up principles, criteria and standards, and conditions for bio-offset arrangements, and finding feasible ways to revise the law and their related regulation to facilitate the birth of a market for biodiversity credits. Within the scope of the amendment of the Law on Biodiversity, basis and method for determining biodiversity damage should be specified; mitigation hierarchy for different levels of reversing biodiversity losses for each type of project (in alignment with EIA exercise) should be stipulated; and distinction between compensation for biodiversity losses and bio-offset is clarified in alignment with proper delegation arrangements of power and responsibilities of relevant stakeholders to ensure its enforcement.

Vietnam has currently had experiences in adopting other funding mechanism for environmental protection and biodiversity conservation with some similarities. For example, the Payment for Forest Environmental Services (PFES) and reforestation system under the Forestry Law 2017 have a strong enforcement mechanism. This arrangement has been viewed as among the most successful payment system for environmental services in Vietnam. Another mechanism of emission inventory and establishment of carbon credit trading market are also being studied and developed under the Law on Environmental Protection 2020. It is expected that the first carbon market can be operationalized in 2028. Learning from those experiences suggests the following possible scenarios for bio-offset adoption in Vietnam:

- Develop a pilot program/scheme/project to research and implement bio-offset in some typical types of projects whose nature enable the adoption in the most straightforward approach. Based on lessons learnt from that pilot exercises, additional requirements can be added to relevant articles of the amended Law on Biodiversity, Environmental Protection Law, and other interconnected regulations, relating to EIA, and environmental permits, among others. This scenario follows the experiences in developing a PFES system.
- Conduct studies and advocate for integration of regulations on bio-offsets into the amended Law on Biodiversity with some delays in implementation for preparation, then newly developed programs and projects are obliged to gradually apply bio-offset requirements, ranging from preliminary to full adoption over time. This approach is similar to the establishment of carbon credit trading mechanism under Decree 06/2022/ND-CP of the Law on Environmental Protection 2020.

Regardless of which scenario is adopted, the next five-year cycle should be critical for studying, piloting this mechanism, preparing needed technical support, and screening the legal gap in the current institutional framework. With careful preparation, Vietnam's institutional readiness for adoption of bio-offsets mechanism can be much improved so that the first biodiversity credit transaction can be realistically expected after 2030.

The last controversial issue for bio-offset adoption is the likelihood of establishing a Bio-offsets Fund in Vietnam as an extra-budgetary fund. It is not a big challenge as long as its existence is stipulated in the amended Law on Biodiversity. Vietnam has also experienced the establishment of the Forest Environment Protection Fund over the last 10 years. From a very simple funding modality at the beginning, the Fund has grown rapidly with increasing perfection of its operational regulations, especially with the idea to use this Fund to manage and utilize (i) revenue collection from carbon credit transactions in the forestry sector, which is being implemented under Decree No. 107/2022/ND-CP (ERPA program) or (ii) deposits for replacement forestation. A similar financial vehicle for the Bio-offset Fund can be plugged into the structure of the Vietnam Environmental Protection Fund with specific regulations for bio-offset practice is a sound option.

In short, when legal binding and technical conditions for fully adoption of an effective bio-offset mechanism in Vietnam are still absent, MONRE can proactively works with development partners to conduct a feasibility study for designing a national scheme and a complete roadmap for developing a bio-offset mechanism in critical sectors, then expanding to all sectors nationwide, and institutionalizing it by integrating into the legislative system. Accordingly, activities by 2030 in this roadmap will concentrate this roadmap on preparing necessary legal, technical and institutional conditions for piloting and learning lessons, and then for formal adoption after 2030.

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A Gis-based Method for Land Suitability Assessment of Coffee in the Central Highland

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Abstract

This study integrates Geographic Information System (GIS) and Multi-Criteria Decision Making (MCDM) to assess and identify optimal areas for coffee cultivation. The findings can aid in decision-making for coffee planning and attract investment for regional development. Additionally, the study provides a methodological framework for identifying suitable areas for other economically significant crops in the Central Highlands. Utilizing spatial tools, potential locations are categorized into four suitability levels: S1 (Highly suitable), S2 (Moderately suitable), S3 (Slightly suitable), and N (Not suitable). Various factors, including soil conditions, topography, and climate, are thoroughly evaluated using a multi-criteria assessment. The study focuses on the Central Highlands of Vietnam, the country's largest coffee-producing region. The findings indicate that Dak Nong has the highest percentage of highly suitable land (50.7%), making it the most favorable for coffee among the listed provinces. Dak Lak has the highest percentage of land that is not suitable (13.7%), indicating more challenges for agricultural use. Overall, the Central Highlands region has a significant portion of land that is moderately to highly suitable for coffee (82.8% combined for S2 and S1). This analysis can help in planning coffee production activities and resource allocation in these provinces.

Keywords: *Land suitability assessment, coffee, multi-criteria analysis, spatial analysis, GIS*

1. Introduction

As populations in developing countries continue to grow rapidly, the demand for food increases accordingly. One significant factor contributing to low crop yields is the lack of assessment regarding the suitability of land for cultivation. Coffee made its way to Vietnam in 1957. Initially, it was cultivated on plantations in the Northern Midlands and North Central regions. By the 1920s, coffee areas were discovered in the Central Highlands. Since 1994, Vietnamese coffee cultivation has rapidly advanced, achieving significant results across various aspects. Today, coffee stands as the second largest agricultural export product in Vietnam. In the agricultural sector, coffee is second only to rice, solidifying its position as a crucial component of the national economy. The Central Highlands region, which includes the provinces of Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong, boasts a total coffee cultivation area of approximately 639,000 hectares, representing 92% of the nation's coffee-growing land. With an average yield of 28.5 tons per hectare—1.1 times higher than the national average—the region produces around 1,669,000 tons of coffee, accounting for 95% of the country's total output. Consequently, coffee trees hold significant importance in both the Central Highlands and Vietnam. Evaluating suitable areas will enhance cultivation efficiency in this region.

Addressing this issue requires conducting land suitability assessments, which can enhance crop yields by ensuring crops are planted in the most favorable locations. According to the FAO, land suitability refers to how well a specific area of land can support a particular use. This assessment can consider the land in its current state or after potential improvements. The classification of land suitability involves evaluating and categorizing specific areas based on their appropriateness for a defined use. For agricultural purposes, this evaluation considers factors such as climate, soil quality, water resources, topography, environmental components, and local knowledge.

The FAO's framework and methods for physical land assessment are extensively used to evaluate land suitability. The classification system from the FAO guidelines (FAO, 2007, 1976) is organized into orders of class, subclass, and unit. This system categorizes land into Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3), Not Suitable (N). The structure of these classifications is depicted in Figure 1.

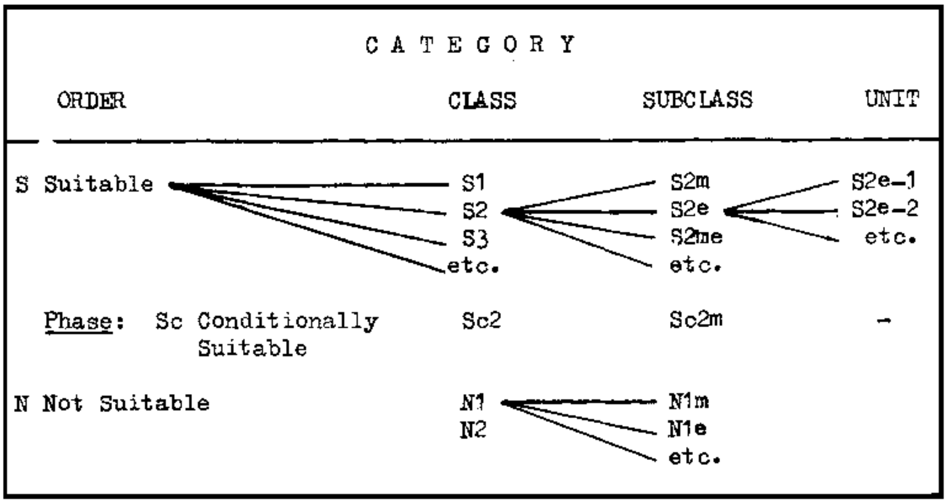

Figure 1: Structure of the land suitability classification

Source: FAO, 1976

Land suitability assessment is crucial for optimizing land resources and plays a vital role in future land use planning. This process typically involves qualitative, quantitative, and parametric analyzes of various soil physiological factors. By employing Multi-Criteria Evaluation (MCE) techniques, the relative importance of different attributes and criteria related to land use and management can be effectively analyzed. In the era of Industry 4.0, advanced technologies such as Geographic Information Systems (GIS) and Remote Sensing (RS) have become integral to this assessment method. Additionally, the insights and expertise of agricultural professionals are essential for evaluating crop suitability. The integration of MCE, GIS and RS has been applied in various agricultural land suitability projects such as agroforestry (Modica et al., 2016), corn (Habibie et al., 2021), wheat (Mendas and Delali, 2012), coffee (Salas López et al., 2020), and rice (Boateng, 2005).

This study focuses on the suitability of land for coffee cultivation in Vietnam's Central Highlands. By integrating MCA, GIS and RS, the research aims to conduct an effective land suitability analysis and guide proper land use management. The findings can aid in decision-making for coffee planning and attract investment for regional development. Additionally, the study provides a methodological framework for identifying suitable areas for other economically significant crops in the Central Highlands.

2. Methodology

2.1. Study areas

The Central Highlands is a region located in central Vietnam, sharing borders with Laos and Cambodia. The total area is about 54,474 square kilometers, making up 16.8% of Vietnam's total land area. It is home to 5.8 million people, which represents 6.1% of the nation's population. This region includes five provinces: Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong. It is a region characterized by numerous adjacent plateaus, each with varying average altitudes. The highest of these is the Lam Vien Plateau, which stands at approximately 1500 meters. These plateaus are bordered to the east by the Southern Truong Son mountain range. The climate falls under the tropical savanna category, featuring two distinct seasons: the rainy season from May to October and the dry season from November to April. March and April are typically the hottest and driest months.

This area is largely red basalt soil located at an altitude of about 500 to 600 meters above sea level. It provides an ideal environment for cultivating industrial crops like coffee, cocoa, pepper, and mulberry. Among these, coffee stands out as the most significant industrial crop in the Central Highlands.

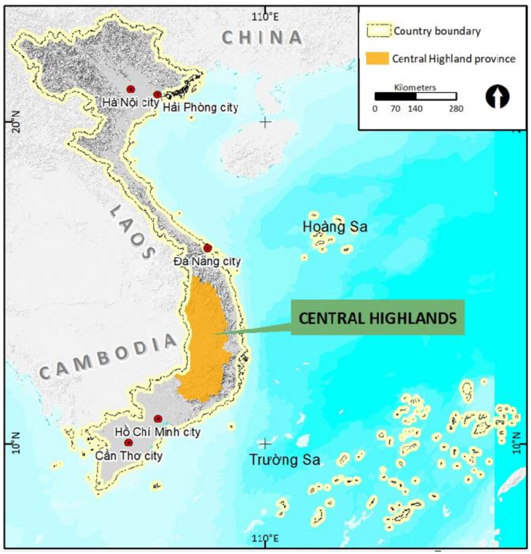

Figure 2: Geographical location of the Central Highlands, Vietnam

Source: Author

2.2. Methodologycal schemes

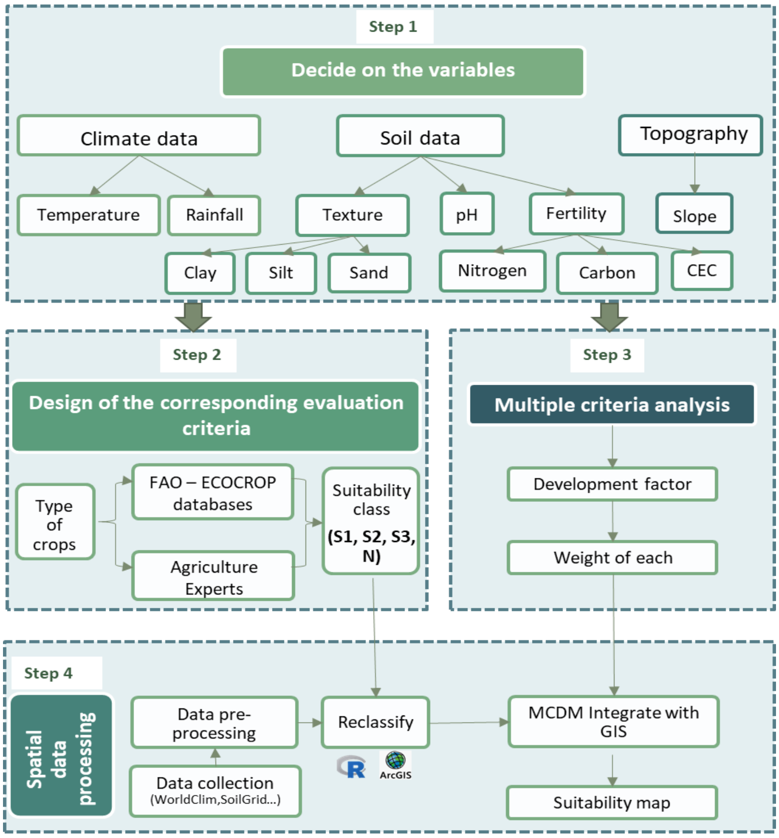

Figure 3: Overall flowchart of the methodology

Source: Author

The overall flowchart of the methodology is shown in Figure 3, which includes four main steps: (1) selecting the variables, (2) designing the corresponding evaluation criteria, (3) applying multiple criteria using AHP (Saaty, 1977), and (4) processing spatial data.

Step 1: Decide on the variables

Through the literature review, the main and sub-criteria related to the development of coffee varieties will be identified. The land suitability assessment process primarily considers three key factors: climate, soil properties, and topography. The three main criteria are further divided into ten sub-criteria. The climatic sub-criteria consist of mean annual temperature and mean annual rainfall. The soil sub-criteria encompass pH, soil texture and soil fertility (nitrogen, carbon, and cation exchange capacity (CEC)). The textural properties of the soil, which depend on the mix of clay, silt, and sand, play a crucial role in this assessment. Lastly, slope aspect is the sole geographical sub-criterion considered in this study...

Once the factors for the land suitability assessment process have been identified, the next step is to collect data from various sources. Table 1 below presents the data collected for assessing land suitability for coffee cultivation in the Central Highlands.

Table 1: Data collection sources for land suitability assessment

Type of data	Description of data	Resolution	Data source
Soil	Soil organic carbon content (C)	250mx250m	https://soilgrids.org/
	Soil nitrogen content (N)	250mx250m	https://soilgrids.org/
	Cation exchange capacity (CEC)	250mx250m	https://soilgrids.org/
	Soil pH	250mx250m	https://soilgrids.org/
	Soil clay content	250mx250m	https://soilgrids.org/
	Soil silt content	250mx250m	https://soilgrids.org/
	Soil sand content	250mx250m	https://soilgrids.org/
Climate	Baseline and projection of temperature	30m×30m	WorldClim ver 2.1 - Baseline from 1970 to 2000
	Baseline and projection of precipitation	30m×30m	WorldClim ver 2.1 - Baseline from 1970 to 2000
Topography	Slope	250mx250m	Global Soil data
	Elevation	250mx250m	Global DEM 250m

Source: Author

Step 2: Design of the corresponding evaluation criteria

This step involves determining the suitability values for each crop. This will be done using the ECOCROP database developed by the FAO. The ECOCROP database identifies 2,568 plant species for various environments and uses, such as food, fodder, energy, erosion control, and industrial purposes. It also includes a library of crop environmental requirements. ECOCROP was designed with relatively basic information on crop environmental requirements. Furthermore, agricultural experts are consulted to determine the appropriate thresholds.

Table 2: EcoCrop environmental limits for Robusta coffee production

Suitable values	Minimum	Optimal min	Optimal max	Maximum
Average Temperature (oC)	**12**	**20**	**30**	**36**
Annual Precipiation (mm)	**900**	**1700**	**3000**	**4000**

Source: Author

Step 3: Multiple criteria with AHP

The Analytical Hierarchy Process (AHP), a multiple criteria decision-making tool particularly effective for spatial or GIS-based problems, will be employed for land suitability assessment. Spatial multi-criteria decision problems typically involve a series of spatial scenarios that serve as alternatives. AHP utilizes pairwise comparisons to evaluate criteria relative to the objective. These comparisons are conducted for all relevant factors within the analysis.

Step 4: Spatial data processing

Spatial data processing plays a crucial role in GIS-based land suitability assessments. Data for these analyses are sourced from various origins and come in different spatial resolutions. These datasets undergo pre-processing steps, such as resampling and aggregation, using GIS tools to prepare them for further analysis. The quality of the final assessment heavily relies on the effectiveness of this spatial data processing. Initially, all spatial data are resampled to a resolution of 250 m × 250 m. Following this, each factor's data is classified according to thresholds established in the second step. Ultimately, GIS-based spatial multi-criteria decision making (SMCDM) is employed to incorporate the perspectives of participants in the decision-making process. In SMCDM, each criterion is assigned a weight that reflects its significance to land use activities. These procedures are carried out and analyzed using ArcGIS and R software.

3. Results

The Central Highlands is the primary hub for coffee production, with Dak Nong leading in terms of highly suitable land for coffee at 50.7%. Kon Tum follows closely with 43.4% of its land being highly suitable (S1), complemented by 45.3% moderately suitable land (S2). Gia Lai also has a significant portion of land suitable for agriculture, with 41.4% highly suitable (S1) and 44.6% moderately suitable (S2). Dak Lak, however, faces more challenges, having the highest percentage of land that is not suitable for agriculture at 13.7% (N), and only 30.5% of highly suitable land (S1). Lam Dong stands out with the largest proportion of moderately suitable land at 49% (S2), though it has less highly suitable land at 32.9% (S1). Overall, the Central Highlands region has a substantial 82.8% of land that is either highly or moderately suitable (S1 and S2) for coffee, indicating strong potential for coffee development across these provinces.

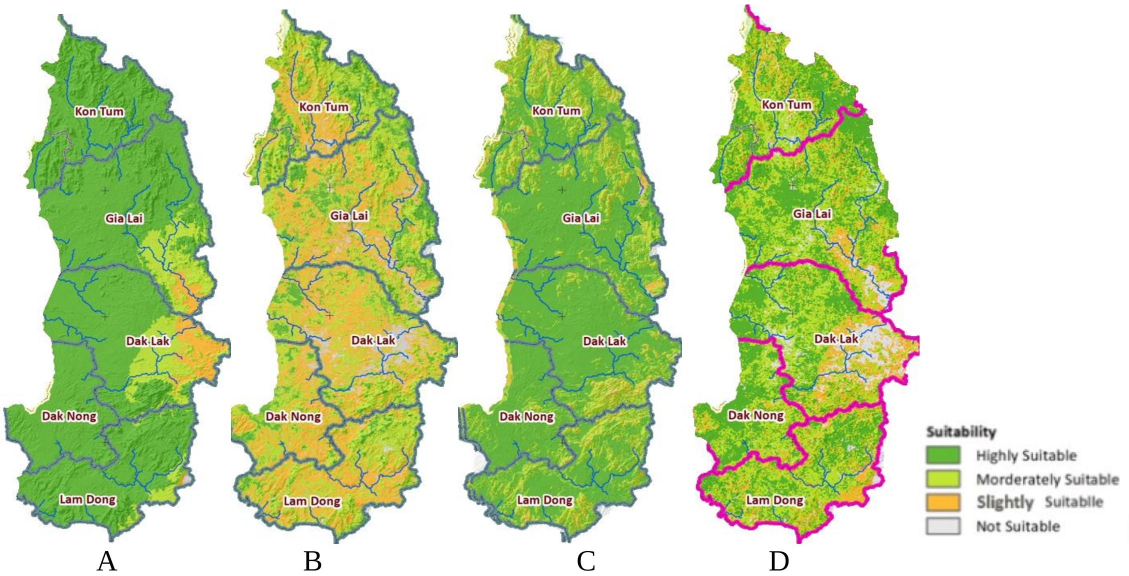

Figure 4: Suitability map (A) Climate, (B) Soi, (C) Topography, and (D) Overal land suitability for coffee in the Central Highlands, Vietnam

Source: Author

4. Conclusion

To foster coffee cultivation in the Central Highlands, the primary criteria are climatology, followed by soil and geography. In this region, Dak Nong has the highest percentage of highly suitable land (50.7%), making it the most favorable for coffee among the listed provinces. Dak Lak has the highest percentage of land that is not suitable (13.7%), indicating more challenges for agricultural use. Overall, the Central Highlands region has a significant portion of land that is moderately to highly suitable for coffee (82.8% combined for S2 and S1). This analysis can help in planning coffee production activities and resource allocation in these provinces.

The combined use of MCA, GIS, and RS effectively identifies areas with potential for coffee growing in the Central Highlands, facilitating proper land management. Additionally, a methodological framework is provided for potential applications to economically valuable crops in the region.

The primary limitation of this study is its reliance on global data, which lacks high resolution. To accurately identify potential areas, it is essential to gather current land use data and future land use plans specific to the locality. Additionally, future research should consider the impacts of climate change, natural disasters, and extreme weather on this region. Given that coffee is a crucial crop in the Central Highlands, detailed studies focusing on the growth characteristics of different coffee varieties are also necessary.

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The Pathway for Sustainable Blue Economy Development: International Evidence and Experience for Vietnam

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Abstract

Vietnam's blue economy holds significant potential for development but faces several challenges, including resource management, environmental sustainability, and infrastructure limitations. This paper analyzes the current state of Vietnam's blue economy, with a focus on fisheries, oil and gas, maritime transport, tourism, and renewable energy. Based on international experiences, particularly from countries like China, the EU, and South Africa, the paper draws lessons for Vietnam's blue economy development. Key recommendations include sustainable resource management, increased investment in research and marine technology, modernization of maritime infrastructure, and enhanced international cooperation. These policies aim to foster sustainable development, enhance economic contributions, and protect marine ecosystems while addressing climate change and environmental degradation.

Keywords: *Blue economy, Sustainable development, Resource management, Renewable energy, International cooperation*

1. Introduction

The Sustainable Development Goals (SDGs) of the United Nations (UN) are crucial for ensuring long-term prosperity and well-being for coastal and island communities. The ocean economy is projected to quadruple by 2030, reaching approximately $3 trillion. The marine economy holds vast potential for expanding economic growth, creating jobs, and reducing poverty, especially in developing countries. Additionally, a sustainable marine economy plays a significant role in addressing global challenges such as climate change, food insecurity, and biodiversity loss (United Nations Development Programme, 2018). It is seen as a method to promote sustainable development in coastal regions and small island nations, while also combating poverty and inequality (Halpern, 2015).

The ability to manage and protect the environment in a sustainable, healthy manner, reduce emissions, and address challenges related to climate change has become increasingly important for many nations. There has been significant growth in renewable energy sectors, with oceans serving as a primary source for renewable energy, such as wind, hydro, and tidal power, all linked to marine ecosystems. The benefits of the marine economy extend to offshore wind, wave, and tidal energy production, offshore aquaculture, dredged marine sediments, and marine biotechnology, which uses marine resources like shellfish, bacteria, and algae to produce medicines and energy. The marine economy also plays a crucial role in international trade as a means of transporting goods. Both the European Union (EU) and the UN have introduced measures and policies to preserve ocean resources and mitigate the impact of climate change on the marine economy over the long term, ensuring that these resources are exploited in a more sustainable manner.

Blue economy activities are closely tied to ocean health and the protection of both natural and social capital (Van Hoof et al., 2019). Oceans and water bodies are recognized as valuable resources that provide new biological products and materials for various industries, while offering ecosystem services that support livelihoods in coastal communities and marine-related value chains (Lillebø et al., 2017). This is reflected in the UN's Sustainable Development Goal 14 (SDG 14), the European Commission's

Green Deal, and the EU's Marine Economy Strategy, which emphasize the importance of maintaining ocean activities that bring economic benefits while fostering the development of a sustainable marine economy. However, the growth of maritime activities must not exert additional pressure on oceans, their resources, and the ecosystems they support (European Commission, 2011).

The High-Level Panel for a Sustainable Ocean Economy (commonly referred to as the "Ocean Panel") asserts that sustainability is the core of the marine economy, marking a shift from purely exploitative approaches. A sustainable marine economy aims for efficient protection, sustainable production, and equitable prosperity from ocean-based activities (Stuchtey et al., 2023). Achieving sustainability in the marine economy context involves multiple facets. According to Lillebø et al. (2017), this must be built upon principles of equitable resource use and exploitation, while bridging economic growth with social and ecological elements that support sustainability. Marine resources are limited, some are becoming increasingly scarce, and their value is rising. This underscores the urgency of investing in research and innovation to protect marine resources, maintain traditional economic activities that depend on them, and develop new, innovative applications and services in emerging fields.

In Vietnam, Resolution No. 36/NQ-TW highlights the existing limitations and the underutilization of the country's marine economic potential. However, the Central Committee of the Communist Party of Vietnam has set clear goals for 2030 and a vision for 2045. By 2030, Vietnam aims to become a strong maritime nation, achieving key criteria for sustainable marine economic development, establishing a marine ecological culture, proactively adapting to climate change and rising sea levels, and reversing trends of marine pollution, environmental degradation, coastal erosion, and seawater intrusion. The resolution calls for the restoration and conservation of vital marine ecosystems, with advanced scientific achievements becoming a direct factor driving the sustainable development of the marine economy. Specifically, the resolution targets that marine-based sectors will contribute approximately 10% to the national GDP by 2030, while the economy of 28 coastal provinces and cities will account for 65-70% of the country's GDP (Resolution No. 36/NQ-TW).

Blue economy sectors must develop sustainably according to international standards, ensuring the exploitation of marine resources within the recovery capacity of marine ecosystems. The human development index (HDI) of coastal provinces and cities is expected to exceed the national average, with the per capita income in these areas reaching at least 1.2 times the national average. Additionally, inhabited islands are to be equipped with essential socio-economic infrastructure, including electricity, fresh water, telecommunications, healthcare, and education. Vietnam is also set to maximize its utilization of advanced scientific and technological achievements, aiming to lead within ASEAN in several areas of marine science and technology, reaching a modern, advanced global level in certain fields. Furthermore, Vietnam will focus on training and developing marine human resources, building a team of highly skilled marine science and technology professionals.

2. International experience in sustainable blue economy development

2.1. China

From 2000 to 2011, China's marine industry increased its contribution to the national economy from 6.46% to 13.83%, while creating over nine million jobs. Many coastal residents rely on fishing for their livelihood, and fish consumption has risen significantly in recent years.

Liu et al. (2019) and Smith-Godfrey (2016) analyzed China's role in global ocean governance. The policies and institutions related to marine environmental protection, fisheries management, and deep-sea mining were examined. The reports highlighted the opportunities and challenges China faces in influencing global ocean governance, providing policymakers and stakeholders with insights to support effective and sustainable ocean governance. In 2014, a study by Jiang et al. (2014) was conducted on the seasonal and regional fluctuations of the phytoplankton community in Lake Chaohu, a major eutrophic lake in China. The phytoplankton dynamics were found to be influenced by water temperature, nutrients, and pH levels. Green technology and sustainable development in China's maritime sector were studied by Huang et al. (2021), emphasizing the potential of green technology for sustainable growth and the importance of integrating environmentally-friendly technology into existing infrastructure to promote sustainable development.

The study also discussed the protection of coastal areas, natural resources, and marine ecosystems to achieve sustainable development, and how this can be accomplished through policy and institutional reforms. Due to widespread misunderstandings, it is important to clarify the concept of the blue economy and its complex relationship with economic growth (Ayres & Warr, 2010). Liu et al. (2019) further analyzed China's sustainable development plan for the marine economy, identifying barriers and potential for sustainable growth. The study shed light on China's marine economic policies and the institutional requirements necessary for sustainable development. Wang & Zhang (2019) conducted empirical research on the relationship between the blue economy and China's economic growth, showing that the blue economy has boosted China's GDP, particularly in coastal regions rich in marine resources. The study highlighted the need for policies and initiatives to promote sustainable and equitable development within the marine sector.

In 2020, a study by Zhou & Yu (2020) analyzed how marine economic development affects China's overall economic growth, demonstrating that the blue economy not only drives growth but also has varying impacts across different regions and industries. The research emphasized the importance of focused policies and strategies to ensure sustainable and inclusive growth in the marine economy.

Conathan & Moore (2015) compared the approaches of China and the United States in developing their marine economies over the years. China's model takes an integrated, interdisciplinary approach to coastal development. It incorporates both traditional marine resources, such as fishing, maritime transport, and oil and gas production, and emerging sectors like marine biotechnology, which seeks new organisms that could prove valuable to the pharmaceutical or cosmetics industries. At the Chinese Communist Party's 2014 work conference, leaders pledged to develop a sustainable marine economy. Conversely, the U.S. focuses its marine economy efforts on four key areas: sustainable fisheries, recreation and tourism, coastal ecosystem restoration, and offshore renewable energy development. The U.S. does not have a direct federal program targeting the blue economy specifically, but where blue economy goals have been advanced, environmental sustainability remains a core priority.

2.2. European Union

The European Commission's Blue Economy Strategy identifies research and innovation as central to promoting the sustainable development of the marine economy, with investments focused on three key areas: (i) achieving climate neutrality, (ii) conserving and restoring marine and coastal ecosystems, and (iii) supporting sustainable innovations for the oceans. The blue economy encompasses all activities related to the exploitation and utilization of ocean resources, as well as the use of coastal and marine spaces for industrial and recreational purposes. It includes traditional industries such as maritime transport and shipping, fisheries, and tourism, alongside rapidly growing new sectors, such as those driving research and innovation in deep-sea mineral extraction, ocean renewable energy, offshore aquaculture, and marine biotechnology (European Commission, 2021).

The European Commission's sustainable blue economy strategy emphasizes the role of science and research in conserving and restoring marine ecosystems while generating new ideas for sustainable and efficient ocean solutions. Achieving the transition to sustainability requires interdisciplinary efforts and collaboration across sectors (Friedman et al., 2020). This is further highlighted by the United Nations' Decade of Ocean Science, which calls for interdisciplinary approaches to addressing ocean and coastal challenges, and improving understanding of the relationship between social and ecological systems.

2.3. South Africa

According to Loureiro et al. (2022), South Africa, like most coastal nations, relies heavily on marine resources to drive its economic development. In 2010, South Africa's blue economy contributed approximately ZAR 54 billion to the national GDP and generated about 316,000 jobs. Furthermore, it is estimated (although without clear methodology reference) that the potential contribution could reach ZAR 177 billion to GDP and over one million jobs by 2033. South Africa boasts an extensive marine space, with nearly 2,798 km of coastline and an Exclusive Economic Zone (EEZ) of approximately 1.5 million km^2, encompassing various oceanographic provinces and ecosystems ranging from sub-Antarctic and cold temperate to subtropical systems. Given this, it is unsurprising that South Africa is promoting blue economy expansion to drive economic development, ensure food and energy security, and expedite the implementation of the National Development Plan (NDP).

The NDP 2030 is a national socio-economic development blueprint aimed at eliminating poverty and reducing inequality by creating job opportunities and balancing access to opportunities by 2030. To accelerate the delivery of NDP 2030, South Africa launched Operation Phakisa in 2014 (with “Phakisa” meaning “hurry” in Sesotho). This program covers multiple national sectors, including the marine economy, under the initiative ‘Operation Phakisa: Unlocking the Economic Potential of South Africa’s Oceans’ (referred to as ‘Ocean Phakisa’). Officially launched in 2014, Ocean Phakisa is based on analyzing the potential of nine national maritime and marine sectors identified as key priorities for advancement. Ultimately, six areas of action were defined: (1) Marine transport and manufacturing; (2) Offshore oil and gas exploration and production; (3) Aquaculture; (4) Marine protection services and ocean governance; (5) Small harbor development; and (6) Coastal and marine tourism (Loureiro et al., 2022).

According to Potgieter (2018), South Africa's vast maritime area, abundant marine resources, and maritime infrastructure contribute significantly to its ocean economy’s role in the national GDP. South African nations focus on four main sectors: maritime transport and manufacturing, offshore oil and gas exploration, aquaculture, and marine protection services and governance, along with small harbor development. However, traditional economic activities and investments in the ocean have spanned various sectors, including the exploitation of living resources (fisheries), non-living or non-renewable resources (oil, gas, and extractive industries), tourism, coastal development, maritime transport, and port infrastructure. Recent technological advancements in regions like Africa have created new and diverse investment opportunities in the maritime space. Nevertheless, given the wealth of the oceans and the economic activities tied to them, security remains a major concern, emphasizing the importance of appropriate national and international governance frameworks to manage ocean resources.

In a study on the marine economy of the Republic of Seychelles, Schutter & Hicks (2019) highlighted Seychelles’ unique position in Africa, due to its remote location in the Indian Ocean, political history, and pioneering role in promoting the blue economy. Seychelles has positioned itself as a leader in Africa in this regard. Consequently, Seychelles has placed itself at the forefront of blue economy development for Africa and island nations, identifying three main perspectives for its domestic blue economy: the ocean as a good business, the ocean as a driver of innovation, and the ocean as natural capital.

2.4. Indonesia

Indonesia has prioritized the implementation of the Sustainable Development Goals (SDGs), which were announced by the President of Indonesia (O'Donnell et al., 2020) and later endorsed by the United Nations (UN) in 2017 (Vu, 2020). The President issued regulations for implementing the SDGs (Jodlbauer, 2021) and established a national coordination team for development objectives, directly led by the President of Indonesia. Indonesia focuses on seven out of the 17 SDGs, which include eradicating poverty, ensuring zero hunger, promoting healthy and prosperous lifestyles, achieving gender equality, conserving marine environments, fostering partnerships to achieve goals, and enhancing industry, innovation, and infrastructure.

Indonesia aims to address fundamental needs, improve living conditions, reduce poverty (Jiang, 2020), eliminate prejudice and injustice (Cruz, 2021), and build a society centered on social justice and human security (Lehnert, 2021). The country faces both opportunities and challenges in achieving the SDGs. Throughout history, humans have been connected to the seas for hundreds of thousands of years. With advances in fishing and navigation technology, the marine environment became a focal point for migration and settlement (Mbachu, 2023). However, marine resources are not only limited to transportation and fisheries; they also encompass minerals extracted from the ocean floor and technologies that transcend international borders. The sea functions as an ecosystem that significantly impacts human life.

3. The current status of Vietnam's blue economy development

Vietnam, with a coastline extending over 3,260 km, has vast potential for marine economic development. The marine economy sectors in Vietnam include fisheries and aquaculture, oil and gas, maritime transport, marine tourism, and renewable energy industries. Through Resolution No. 36/NQ-TW by the Central Committee of the Communist Party, Vietnam has clearly set the goal of becoming a strong maritime nation by 2030, achieving sustainable development in all aspects. However, Vietnam's marine economy is currently facing significant challenges, requiring improvements in resource management and utilization (Resolution No. 36/NQ-TW).

3.1. Contribution of the marine economy to GDP

Currently, the marine economy contributes approximately 10-12% of the national GDP. According to the General Statistics Office (2020), the primary marine economic sectors have contributed an estimated VND 670 trillion, equivalent to 10.3% of GDP. Among these, the oil and gas extraction and fisheries sectors have the largest shares, accounting for nearly 70% of the total marine economy's production value. The oil and gas sector plays a crucial role in boosting exports and generating significant foreign currency revenue for the country, while the fisheries sector supplies millions of tons of seafood to both domestic and international markets.

3.2. Fisheries and aquaculture

The fisheries sector is one of the most important components of Vietnam’s marine economy, with a total seafood production of approximately 9.3 million tons in 2023 (General Statistics Office, 2023). However, overexploitation and unsustainable practices have led to a decline in fishery resources, especially high-value species. Many fishing grounds have been overexploited to the point of depletion, and marine ecosystems are seriously impacted by illegal and poorly managed fishing activities. According to a report from the General Department of Fisheries, 85% of Vietnam's fishing grounds are currently overexploited.

In the aquaculture sector, Vietnam has made significant progress, with total aquaculture production reaching approximately 5.5 million tons in 2023, accounting for 59% of the country’s total seafood output. However, this sector also faces many environmental challenges, particularly the dependence on antibiotics and chemicals, which leads to water pollution and a decline in product quality.

3.3. Oil and gas and renewable energy

The oil and gas sector is the largest contributor to Vietnam’s marine economy, accounting for up to 60% of marine export revenue. Oil and gas extraction activities are concentrated mainly in fields on the southern and southeastern continental shelf of Vietnam. In recent years, this sector has contributed billions of USD to the national budget; however, oil resources are gradually being depleted, and the oil and gas sector is facing many challenges related to extraction technology and resource management.

Meanwhile, renewable energy, particularly wind and solar energy, is seen as a new direction to replace traditional oil and gas resources. According to Vietnam’s renewable energy development plan, the goal is to increase investment in offshore wind and solar energy by 2030, with a total projected capacity of around 6,000 MW.

3.4. Marine transport and marine tourism

Marine transport is a key sector of the marine economy, playing an important role in connecting Vietnam to the global market. Currently, Vietnam has approximately 44 seaports, with a total cargo handling capacity of about 600 million tons per year. However, the seaport system has not been uniformly developed, with many ports lacking modern infrastructure and operating below optimal capacity.

3.5. Challenges in resource management and marine environment

One of the biggest challenges facing Vietnam’s blue economy is the lack of sustainability in resource management and exploitation. Oil and gas extraction, fisheries, and coastal tourism activities have caused significant negative impacts on the marine environment, particularly water pollution and coastal erosion. According to the Ministry of Natural Resources and Environment, Vietnam loses approximately 300-500 hectares of coastline to erosion each year, severely affecting ecosystems and the livelihoods of coastal communities.

Additionally, climate change poses a major challenge to the sustainable development of Vietnam's marine economy. Rising sea levels, storms, and land erosion are increasing, directly threatening coastal areas and marine economic infrastructure.

4. Lessons learned for sustainable blue economy development in Vietnam

Vietnam must develop its blue economy while protecting the environment, following the example of countries like China and the European Union. This requires sustainable marine resource management, limiting overexploitation, and investing in marine conservation areas. The application of environmentally friendly technologies in fisheries, oil and gas, and tourism is crucial to ensure a balance between development and ecosystem protection. Furthermore, reducing marine pollution and coastal erosion will help protect the livelihoods of coastal communities.

Investing in marine research and technology is essential. Vietnam should learn from the EU and South Africa to develop advanced technologies for renewable energy exploitation from the sea, such as wind and wave energy. The application of advanced technology not only opens up new economic opportunities but also helps protect the environment. Additionally, marine biotechnology plays an important role in the sustainable exploitation of marine resources.

Marine infrastructure must be modernized to support economic development. Vietnam should upgrade its seaports, coastal industrial zones, and aquaculture areas based on the experiences of South Africa. This will not only enhance transportation capacity but also improve international competitiveness. Marine tourism also requires investment in sustainable tourism infrastructure, ensuring that economic development goes hand in hand with environmental protection.

International cooperation is a key factor. Vietnam needs to establish research and technology-sharing partnerships with developed nations in the maritime sector, similar to South Africa's "Operation Phakisa." At the same time, strengthening state management capacity in monitoring and enforcing marine policies is essential. Through international cooperation, Vietnam can access funding, technology, and knowledge to develop a sustainable marine economy.

5. Conclusion and Policy implications

Vietnam's blue economy holds great potential for development, but it faces numerous challenges in resource management, environmental protection, and infrastructure. To ensure sustainable development, Vietnam needs to apply lessons learned from international experiences while implementing effective policies to manage marine resources responsibly, protect the environment, and promote marine economic growth.

First, comprehensive marine resource management policies must be developed to ensure sustainable and responsible exploitation of resources. This includes limiting overfishing, protecting marine ecosystems, and encouraging the use of environmentally friendly technologies in marine-related industries. Effective marine resource management will help maintain ecological balance and preserve resources for future generations.

The government must intensify investment in marine research and technology development, particularly in renewable energy sectors such as wind and wave energy. Research programs should focus on improving resource exploitation efficiency and developing new technological solutions to minimize environmental impacts. This will not only help Vietnam meet its sustainable development goals but also open up new economic opportunities in the future.

Upgrading marine infrastructure is one of the critical factors for marine economic development. Seaports, coastal industrial zones, and aquaculture areas must be modernized to enhance transportation and export capacity, optimizing economic efficiency from the sea. Modern infrastructure will not only support economic development but also contribute to marine environmental protection.

Finally, enhancing international cooperation is a crucial solution for Vietnam to learn from global experiences and access advanced technologies in the maritime sector. Collaboration with international organizations and countries with expertise will help Vietnam achieve sustainable development goals and contribute to global efforts in marine environmental protection. The implementation of these policies will enable Vietnam to maximize its marine economic potential, ensure sustainable development, and strengthen its economic position both regionally and globally.

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The Role of Environmental Education in Sustainable Development Goals

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Abstract

As global challenges such as climate change and resource depletion intensify, the role of education in fostering sustainable development becomes increasingly vital. This research examines the critical role of environmental education in advancing the Sustainable Development Goals (SDGs), specifically SDG 4, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Through a comprehensive literature review and content analysis, the research identifies key themes, trends, and gaps in existing literature regarding the intersection of environmental education and the SDGs. The review encompasses scholarly articles, policy documents, and educational frameworks to assess how environmental education contributes to sustainability and supports the achievement of SDG 4. The findings highlight the importance of integrating environmental education into curricula and policies to enhance environmental literacy and foster sustainable practices. The research underscores the need for continued focus on environmental education as a fundamental component of global efforts to achieve sustainable development.

Keywords: *Environmental education, sustainable development goals, SDG 4, climate change*

1. Introduction

Around the globe, there is a growing call for leadership in addressing issues like education, poverty, inequality, and climate change **(**Barraza et al., 2003**).** In response, world leaders convened in 2015, at the United Nations in New York to endorse the 2030 Agenda for Sustainable Development. This agenda introduces 17 Sustainable Development Goals (SDGs) and 169 targets designed to guide global policy and funding efforts for the next 15 years, involving "all countries and stakeholders in a collaborative partnership." This initiative begins with a historic commitment to eradicate poverty worldwide and sets measurable objectives across the social, economic, and environmental dimensions of sustainable development under the guiding framework "for people, planet, and prosperity." These goals and targets are universal, acknowledging diverse national contexts, capacities, and developmental stages while respecting national policies and priorities. To support these goals, a set of indicators and a monitoring framework will be developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs), with their recommendations presented to the UN Statistical Commission in March 2016. The SDG concept originated at the United Nations Conference on Sustainable Development, Rio+20, in 2012. The aim was to create a universally applicable set of goals balancing the three dimensions of sustainable development: environmental, social, and economic. The SDGs replace the Millennium Development Goals (MDGs), established in 2000, which united the world around a 15-year plan to tackle the indignities of poverty. The MDGs set measurable, globally agreed objectives to eradicate extreme poverty and hunger, combat treatable diseases, and expand educational opportunities for all children, among other critical development goals. However, the work remains incomplete for millions of people, with ongoing challenges in eradicating hunger, achieving full gender equality, improving health services, and ensuring every child receives an education. The SDGs are intended to complete the work begun by the MDGs, ensuring no one is left behind. Building on the eight anti-poverty targets of the MDGs, the SDGs extend their scope to address the root causes of poverty and the universal need for development that benefits all people. As noted by UNDP Administrator Helen Clark, "This agreement marks a crucial step toward placing our world on an inclusive and sustainable trajectory. If we work together, we have a chance to meet people's aspirations for peace, prosperity, and well-being while preserving our planet." The SDGs are set to finalize the goals of the MDGs, ensuring inclusivity for all.

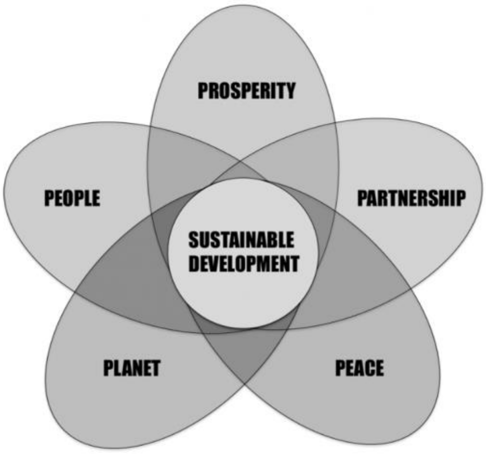

Figure 1: SDG Agenda highlights five key themes

Source: UN Sustainable Development Goals, 2015

The 17 SDGs represent a unified and comprehensive set of global aspirations that the world aims to achieve by 2030. They build upon the achievements of the MDGs and address the most urgent global challenges, calling for collaborative partnerships between and within countries to balance the three dimensions of sustainable development—economic growth, environmental sustainability, and social inclusion (The United Nations, 2015). The SDG agenda addresses these interconnected challenges, making it broader and more complex than the MDGs. Most importantly, it adopts sustainable development as the organizing principle for global cooperation, integrating economic growth, social inclusion, and environmental sustainability. This approach is encapsulated in the title "Sustainable Development Goals," emphasizing the message to the global community. Additionally, the SDGs and their associated agenda apply to all nations, both developed and developing. According to the Sustainable Development Solutions Network (2013), the post-2015 agenda encourages a shift away from "business as usual" approaches, advocating for the sustainable use of resources and the promotion of peaceful and inclusive societies. The outcome document for the SDG Agenda highlights five key themes: people, planet, prosperity, peace, and partnerships, as depicted in Figure 1. Goal-based planning benefits from complementing international conventions and other legal frameworks by providing a globally shared normative structure that fosters international collaboration, mobilizes stakeholders, and inspires action. Well-designed goals can create a shared narrative of sustainable development, helping the public to understand complex challenges, uniting the global community, and mobilizing stakeholders. Community leaders, politicians, government ministries, academics, NGOs, religious groups, international organizations, donor agencies, and foundations are encouraged to come together with a common purpose around each SDG, supporting long-term strategies for sustainable development, and defining responsibilities while fostering accountability (Sustainable Development Solutions Network, 2013).

2. Methodology

This study employs a literature review with content analysis to analyze the role of environmental education in achieving the Sustainable Development Goals (SDGs), with a particular focus on SDG 4. A comprehensive review of existing literature on environmental education and the SDGs was conducted to identify key themes, trends, and gaps in current research. This review includes scholarly articles, policy documents, and educational frameworks relevant to environmental education and sustainable development.

3. Results

3.1. Education and SDGs

Education is recognized globally as a fundamental element for sustainable development. It plays a crucial role in effectively managing the world's increasingly strained natural resources by integrating successful environmental education strategies. Such education equips students with the knowledge, skills, and experiences necessary to become successful community leaders and make informed decisions regarding resource management. Education has made significant contributions to societal and global development and is acknowledged for its critical role in improving livelihoods worldwide. Quality education prepares societies to engage actively in global political and economic arenas and equips individuals with the skills needed to make informed decisions and act responsibly. Globally, education has been identified as a cornerstone of sustainable development, which, since its inception over 30 years ago, has been promoted as an effective means to curb the degradation of human and environmental systems (The World Bank, 2015). Sustainable development focuses on the economy, society, and the environment to achieve its objectives (Hart, 1997). However, the term can sometimes be misused or overemphasized in policy endorsements, shifting attention away from the strategy's original environmental goals and instead focusing on social or economic aspects. It is essential that sustainable development's economic, social, and environmental aspects are equally represented and balanced in policy formation.

3.2. Environmental education and SDGs

The aims of SDG 4 are to ensure inclusive, equitable, and quality education while promoting lifelong learning opportunities for all. Achieving this goal underscores the belief that education is one of the most powerful and proven drivers of sustainable development. This objective includes ensuring that all girls and boys complete free primary and secondary education by 2030, providing equal access to affordable vocational training, and eliminating gender and wealth disparities to achieve universal access to quality higher education. The goal also seeks to ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including education for sustainable lifestyles, human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship, and an appreciation of cultural diversity. This goal is integral to all SDGs, emerging as one of the most critical for their collective success. Since education and human resource development are central to this goal, areas such as education for sustainable development, environmental education, peace education, vocational education, and higher education must be accessible to everyone across all societal sectors to ensure the success of the SDGs. In this context, Environmental Education (EE) and Education for Sustainable Development (ESD) are specialized fields that directly address environmental conservation and protection. Organizations responsible for implementing courses and curricula in education systems should clearly outline their initiatives toward achieving this goal. Given the substantial focus on achieving this goal, it is anticipated that such efforts will enhance environmental literacy, reflected in improved attitudes toward the environment and better responses to environmental challenges.

Environmental education is an interdisciplinary field, drawing on the social, physical, and biological sciences. According to the Environmental Education and Training Partnership (EETAP), environmental education empowers citizens to make informed decisions about their environmental behaviors based on the awareness, knowledge, skills, and attitudes they acquire. Environmental education utilizes both formal and informal teaching methods to achieve its ultimate goal of encouraging informed and positive environmental actions. It incorporates various disciplines, techniques, and resources to meet its objectives. Since students learn through a range of non-traditional intelligences, such as naturalistic, interpersonal, or intrapersonal, environmental education can bridge multiple learning styles. Its methodologies and goals can be integrated into the SDGs' objectives for sustainable development in education. Education that emphasizes sustainable development and critical thinking has a greater likelihood of success, and the multidisciplinary nature of environmental education makes it an ideal strategy for development. However, environmental education in developing countries often has different success criteria due to varying socio-economic factors. There is a significant need to link environmental quality, human equality, and human rights to enhance the effectiveness of environmental education and development. Environmental education that emphasizes ownership and empowerment is crucial in promoting education for sustainable development. Increased youth participation in environmental investigation and decision-making can lead to a greater sense of empowerment and achievement, contributing to sustainable development and educational reform goals. Therefore, educational programs aiming to achieve both sustainable development and environmental education goals should emphasize student participation and action to foster stronger ownership and empowerment in the learning process. For SDGs to be effectively implemented and successful, environmental education must be emphasized, and curricula on environmental courses should focus on local environmental issues that students encounter daily, equipping them with the skills needed to address such challenges. Simply discussing broader issues like global warming and climate change will not yield effective results. Additionally, activities that expose students to nature should be regularly included in the curriculum. Frequent interaction with nature may inspire students to undertake projects that positively contribute to environmental conservation.

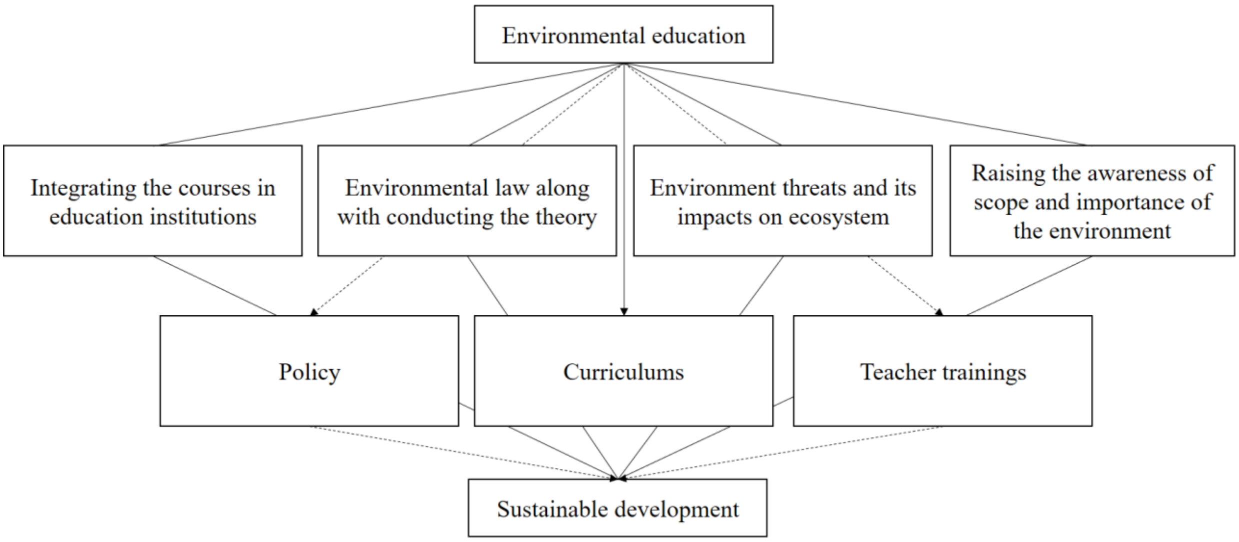

Figure 1: Sustainable development through environmental education

Source: Yadav et al, 2022

4. Discussion and Conclusion

Environmental education programs that successfully address educational reform and sustainable development incorporate various factors. According to the Sustainable Development Solutions Network (2013) and Sustainable Development Solutions Network (2015), the combination of the global need for improved education and the rapid environmental degradation has created opportunities for environmental education programs to enhance both areas. Programs focusing on familiar environments and communities promote student success and confidence on a local level, laying the groundwork for addressing larger societal and environmental challenges in the future. Programs based on sound structural processes provide students with an optimal learning environment to develop essential life skills. Moreover, a long-term commitment to student development and resource conservation allows students to understand, investigate, and resolve the issues they encounter. However, changing political environments, whether directly or indirectly, can impact the educational process and must be considered. To achieve the SDGs, global citizens must be equipped with the skills to confront future challenges. Utilizing the environment as a unifying theme in education can effectively provide these skills. Environmental protection is considered a crucial goal at all educational levels, as envisioned by environmental education, which is dedicated to this cause (Wilson, 2002). Therefore, the SDGs must be adopted at the grassroots level, where they have the greatest impact. The goals, associated indicators, and monitoring processes must be decentralized to the communities they are intended to benefit. The successful implementation of these goals is dependent on the effective dissemination of SDGs within each community, taking into account the specific needs, barriers, and opportunities that communities face. Although these goals are important at the national and international levels, their success largely depends on how well they are understood and embraced by local communities. The dissemination of the SDGs should be tailored to meet the unique needs of each community, empowering individuals to take ownership and actively contribute to achieving the goals. As sustainable development becomes more integrated into educational systems, environmental education can serve as a powerful tool to promote awareness, understanding, and action toward achieving the SDGs. By fostering a deep connection to the environment and emphasizing the importance of sustainable practices, environmental education can inspire the next generation of global citizens to take responsibility for the future of our planet.

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SECTION VI

DIGITAL TRANSFORMATION

Impact of Digital Transformation on Tax Avoidance Behaviors of Non-Financial Enterprises on the Stock Market

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Abstract

This paper is aimed at the impact of digital transformation on corporate tax avoidance. Data is collected from FiinPro and annual reports of 152 non-financial listed firms on the Vietnam stock market from 2018 to 2023. The research applied the methodology of GMM 2-step to analyze the relationship between digital transformation and tax avoidance. The result reveals a strong negative correlation: higher levels of digital transformation are associated with lower tax avoidance. This suggests that actively promoting digital adoption is a crucial strategy for ensuring a reliable and sustainable national tax revenue base. The study contributes to the theoretical understanding of digital transformation's impact on tax avoidance. It offers valuable insights for policymakers and tax researchers seeking to foster the integration of digital and real economies.

Keywords: *Digital transformation, book-tax difference, tax avoidance, taxable income*

1. Introduction

Tax is a legitimate obligation and an important cost in the operation of enterprises that significantly impacts an enterprise's cash flow and profitability (Tiantian et al., 2023). Unlike tax evasion, which is illegal, companies engage in tax avoidance by exploiting loopholes and ambiguities within tax laws and regulations to minimize their tax liabilities. However, for firms, tax avoidance can decrease the transparency of a firm's operations, cost of capital, and firm value (Brühne & Jacob, 2020). Moreover, there is a link between corporate tax avoidance and government corruption (Sun, 2021). That is why corporate tax avoidance has become an increasingly concerning issue in recent years in every country.

In the era of Industry 4.0, digital technology has permeated every corner of business operations, from production to marketing, and customer service (Li, 2020), and plays a crucial role in helping companies maintain a competitive edge. Digital transformation can enhance corporate governance by reducing information asymmetry (Zhao et al., 2023) and principal-agent conflicts (Ivaninskiy et al., 2023), leading to better managerial behavior, improved corporate structure, and higher performance (Tiantian et al., 2023; Lin & Kunnathur, 2019; Li et al., 2022). According to the World Intellectual Property Organization, 2023 marks an important milestone for Vietnam's Innovation Index by ranking 46th, up 2 places compared to 2022. Given this, digital transformation is thriving in Vietnam. That's why examining the relationship between digital transformation and tax avoidance in Vietnam is essential for both businesses and the government in today's global economy.

Previous research in other countries has found some evidence of a link between digital transformation and company tax avoidance characteristics (Chen et al., 2024; Lestari & Kholid, 2024). However, in Vietnam, current materials about tax avoidance have not recorded digital transformation as an important factor (Nguyen & Nguyen, 2021; Nguyen, 2024; Nguyen & Phan, 2017); the latest published works on corporate digital transformation have also not mentioned tax avoidance (Vo et al., 2024;

Nguyen et al., 2024). Therefore, our research aims to investigate tax avoidance by examining the impact of digital transformation and other factors. Unlike previous studies, we incorporate digital transformation as an independent variable, providing a novel perspective on tax avoidance in the Vietnamese context.

Our study makes significant contributions to the literature in the following aspects. First, we enrich the literature on the relationship between corporate digital transformation and tax avoidance in Vietnam. Second, we provide suggestions for ensuring the authenticity and stability of national tax revenue. Our findings suggest that, from a micro perspective, standardizing corporate governance by implementing corporate digital transformation decreases tax avoidance.

2. Theoretical framework

2.1. Tax avoidance behavior of non-financial firms

Corporate tax avoidance refers to actions and behaviors conducted within the legal framework but exploiting the weakness of the law to reduce the tax burden for firms. Research on corporate tax avoidance provides opinions based on two perspectives: external and internal influencing factors. In terms of external factors, Xie & Huang (2023) argued that tax avoidance behaviors are impacted by the quality of tax management. The stricter the tax management, the less tax avoidance. Internal factors such as information environment (Gallemore & Labro, 2015), corporate governance (Pham et al., 2024), and corporate characteristics (Nguyen, 2024) also have significant effects on tax avoidance. Despite being legal, tax avoidance is considered to be a negative phenomenon because of mitigating the government tax revenue and endangering national financial stability (Pham et al., 2024). For firms, while tax avoidance reduces the risk (Feng et al., 2021), it negatively impacts company performance (Vu & Pham, 2023).

According to Sudibyo, Y. A., & Jianfu, S. (2016), firms are divided into private firms and state-owned enterprises (SOE). State-owned enterprises often benefit from having more stable connections with tax authorities. This positively correlates to tax managing skills and ultimately enhances their overall tax compliance capabilities compared to private firms.

2.2. Digital transformation of non-financial firms

Verhoef et al (2021) defined digital transformation as “A change in how a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm”. Current studies on the digital transformation of enterprises have been carried out mainly on two aspects: influencing factors and economic consequences. In terms of influencing factors, Verhoef et al. (2021) argued that the external factors of digital transformation are digital technology, digital competition, and digital customer behavior. Besides, the learning capability and dynamic capability of the company generate the internal motivation to promote the process of corporate digital transformation (Xie & Huang, 2023). Regarding economic consequences, Zeng et al. (2022) concluded that digital transformation improves businesses's financial performance. Also, digital transformation increases stock liquidity and decreases the risk of stock price crash (Liu et al., 2024). Zhou et al. (2021) claimed that digital transformation provides enterprises with knowledge based on analyzing data and facilitates better decision-making.

3. Methods

3.1. Hypotheses development

Impact of digital transformation on tax avoidance behavior of non-financial firms

Asymmetrical information and benefit conflicts between managers and shareholders are the key reasons for the agency problem. Digital transformation is expected to alleviate this issue for enterprises. First of all, technology innovation brings a new encounter for business governance. Utilizing digital techniques to collect and analyze data enhances information transparency, changes the relationship between managers and shareholders, and diminishes agency costs. In addition, benefit conflicts can be lessened by applying digital transformation to improve enterprises' financial performance. The higher the efficiency of a business is, the less motivation managers have to avoid tax. Moreover, the high quality of internal governance plays an important role in efficiency monitoring and preventing managers from avoiding tax (Tiantian et al., 2023). Therefore, the following hypothesis is formulated in this study:

H1: Digital transformation has a negative effect on corporate tax avoidance.

Impact of state ownership on tax avoidance behavior of non-financial firms

State-owned corporations have always played an important role in the economy, and the relationship between state ownership and corporate tax avoidance has been examined. The study by Nguyen & Phan (2017) and Wu et al. (2013) indicate a negative relationship between tax avoidance and state ownership. This may be attributed to their focus on broader societal and political objectives, rather than solely maximizing corporate value. Moreover, tax payment of state-owned firms often represents the effectiveness of state investment and performance. Based on these findings, we propose the second research hypothesis as below:

H2: State ownership has a negative relationship with Tax Avoidance

3.2. Sample selection and data sources

The sample of this study includes 152 listed companies on the Hanoi Stock Exchange (HNX) and Ho Chi Minh Stock Exchange (HOSE) that meet the following criteria:

(i) Companies must have maintained continuous listing during the research period from 2018 to 2023. Firms that do not have complete data for at least five years are not considered;

(ii) Companies must belong to the non-financial sector as the financial sector has distinct business characteristics compared to the rest;

(iii) Companies must have complete audited financial statements during the research period.

After excluding firms that do not meet the above criteria, the research sample consists of 152 non-financial firms, corresponding to 912 observations in the period 2018-2023. The research data were sourced from the audited financial reports of the sample companies, retrieved from the FiinPro database covering the years from 2018 to 2023.

3.3. Variables and hypotheses in the model

To assess the extent of corporate tax avoidance, we utilize the tax accounting difference (BTD) which is more optimal than the ETR (Effective Tax Rate) method as our dependent variable (Guenther, 2014), adhering to the framework established by Manzon & Plesko (2001). The BTD is the difference between the pretax profit and the taxable income of an enterprise, and the larger the difference, the greater the degree of tax avoidance of the enterprise. It is calculated as follows:

$$BTD = \frac{Total\ profit\ before\ tax\ for\ the\ period\ -\ taxable\ income\ for\ the\ period}{Total\ assets\ at\ the\ end\ of\ the\ previous\ period}$$

$$Taxable\ income = \frac{Current\ income\ tax\ expense - Current\ deferred\ income\ tax\ expense}{Nominal\ income\ tax\ rate}$$

This study uniquely focuses on the digital transformation of Vietnamese listed firms. The language used in the annual reports of these firms can reveal their plans and strategic direction for digital transformation (Zhao et al., 2022). Besides, Unerman (2000) suggests that the frequency of a term in an annual report indicates its significance level. When it comes to measuring large sample texts, Roberts (2020) recommends using the word frequency approach as the most suitable quantitative method. Therefore, analyzing the text in the annual reports of listed companies can effectively show their strategic orientation (Wu, 2016). "Digital transformation" is an essential development strategy, and the related words and phrases are likely to be present in the annual reports of these companies. Thus, it is feasible and reasonable to use word frequency statistics from the featured lexicon involving "digital transformation" within annual reports to depict the level of digital transformation of listed companies (Tiantian et al., 2023). Other control variables were collected from firms' financial statements, which are available on Fiinpro database.

Table 1: Variables and hypotheses

Variable	Abbreviation	Formula	Source
Dependent variable			
Tax Avoidance	BTD	BTD = $\frac{(Accounting\ Profit\ before\ Tax - Taxable\ Income)}{Total\ Asset}$	Tiantian et al. (2023)
Independent variables			
Digital Transformation	DT	DT = Logarithm natural of the frequency of the words in the keyword set related to "digital transformation"	Xie & Huang (2023)
Audit Quality	BIG4	1 if the company is audited by the big 4 (PwC, Deloitte, KPMG, and Ernst &Young), 0 otherwise	Pham et al. (2024)
Age	AGE	Natural logarithm of firm age (AGE), measured from the year of incorporation to the end of the sample period	Beasley (1996)
Inventory Intensity	INV	INV= $\frac{Inventory}{Revenue}$	To & Tran (2022)
Growth	GROWTH	Growth = $\frac{Revenue\ (t) - Revenue\ (t-1)}{Revenue\ (t-1)}$	Wahyuni et al. (2019)
Financial leverage	LEV	$LEV = \frac{Total\ Debt}{Total\ Assets}$	Nguyen (2024)
Fixed Asset Intensity	FAI	$FAI = \frac{Total\ Fixed\ Asset}{Total\ Assets}$	Lestari & Kholid (2024)
Variable	**Abbreviation**	**Formula**	**Source**
Total year-end assets	SIZE	Size = Logaritma Natural (Total Asset)	Nguyen (2024)
Nature of shareholding	SOE	1 if the company is a state-owned enterprise, 0 otherwise.	Nguyen & Phan (2017)
Return on equity	ROE	$ROE = \frac{Net\ income}{Total\ Equity}$	Nguyen (2024)
Concentrate the company's capital	CAP	$CAP = \frac{Total\ Fixed\ Asset}{Revenue}$	Francis (2014)

Source: Authors' compilation

3.4. Research Model

Building upon the empirical model presented by Wang et al. (2018) and Zhou et al. (2022), this study examines the effects of digital transformation on corporate tax avoidance among 152 Vietnamese listed companies over the period 2018-2023.

Following is the research model:

$$Tax\ avoidance_{it} = \beta_0 + \beta_1 * DT_{it} + \beta_2 * size_{it} + \beta_3 * lev_{it} + \beta_4 * cap_{it} + \beta_5 * age_{it} + \beta_6 * growth_{it} + \beta_7 * roe_{it} + \beta_8 * inv_{it} + \beta_9 * fai_{it} + \beta_{10} * big4_{it} + \beta_{11} * soe_{it} + \varepsilon_{it}$$

in which i and t represent a firm and time.

3.5. Research method

Multiple linear regression was employed in our study to test the hypotheses. Model defect tests, multicollinearity, heteroskedasticity, and autocorrelation, were performed, from which the most suitable multiple regression method was selected for the study. The variance inflation factor (VIF) and tolerance values are calculated as part of collinearity statistics to check the multicollinearity. The results indicate that there is no multicollinearity between independent variables in our model when the VIF values among the variables are lower than 3. Besides, heteroskedasticity and autocorrelation can lead to inconsistent and biased estimates of standard errors, which may invalidate statistical tests of significance and predictions drawn from the model. The White and Wooldridge tests were carried out, and the results confirmed the appearance of heteroskedasticity. Therefore, our study employed a 2-step generalized method of moments (GMM) to explore how digital transformation affects corporate tax avoidance. 2-step GMM utilizes orthogonality conditions to achieve efficient estimation in the presence of heteroskedasticity (Baum et al., 2003).

4. Results

Table 2 presents the descriptive statistics of all variables. The results show that average tax avoidance by listed companies is at 0.005 as measured by BTD. The large standard deviation of dependent variable, which is 0.065, suggests that there are large differences in tax avoidance among the studied firms. The independent variable DT ranges from 0.000 to 6.402, with a mean of 2.175, implying that the level of digital transformation among firms is different, similar to the descriptive statistical results of Vo et al. (2024). It is necessary to improve the firm's digital transformation process. In addition, the statistical description shows that the distributions of other variables are within a reasonable range.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
BTD	912	.005	.065	-.959	.595
DT	912	2.175	1.305	0	6.402
SIZE	912	28.642	1.741	24.477	34.135
AGE	912	2.244	.605	0	3.178
CAP	912	.615	1.208	.002	7.6
INV	912	.434	1.064	0	8.094
GROWTH	912	.104	.438	-.713	2.392
LEV	912	.471	.203	.031	.858
ROE	912	.122	.216	-3.294	2.247
FAI	912	.247	.214	0	.928
BIG4	912	.474	.5	0	1
SOE	912	.204	.403	0	1

Source: Authors' compilation from second data

Empirical results by the 2-step GMM method, which is effective in dealing with autocorrelation and heteroskedasticity, are summarized in Table 3, in which corporate tax avoidance is measured by BTD variable, while DT represents the degree of digital transformation. The robustness of GMM estimation depends on the number of instruments used in the model and the assumption of zero serial correlation. Accordingly, Hansen's (1982) test and Arellano-Bond's (1991) autocorrelation test provide evidence of the accuracy of the GMM method.

Empirical results by the 2-step GMM method are summarized in Table 3. The results show that DT is negatively correlated with tax avoidance, which implies the higher the corporate digital transformation, the lower the level of tax avoidance. This confirms that hypothesis H1 is valid. Meanwhile, regression results also suggest that the state ownership (SOE) negatively affects firms' level of tax avoidance at 1% significance level, which indicates that the level of tax avoidance by state-owned enterprises is lower than that of private firms. The AR (2) test has a p-value of 0.322 > 0.05, indicating that there is no second-order autocorrelation, while the Hansen test has a p-value of 0.367 > 0.05, suggesting that the endogenous and instrumental variables used in the model are appropriate.

Table 3: Empirical results

Variables	Coeff.	Std. Err.	z	P>|z|
BTD_{t-1}	0.176***	0.0442	3.98	0.000
DT	-0.0111***	0.00229	-4.82	0.000
SIZE	0.00715*	0.00329	2.17	0.030
AGE	0.000271	0.00469	0.06	0.954
ROE	0.0439**	0.015	2.92	0.003
CAP	-0.00345***	0.00102	-3.37	0.001
GROWTH	-0.00321***	0.000926	-3.46	0.001
LEV	-0.124***	0.0256	-4.83	0.000
INV	0.000563***	0.000165	3.42	0.001
FAI	0.0971***	0.0162	5.99	0.000
BIG4	0.00251	0.0178	0.14	0.888
SOE	-0.0486**	0.0156	-3.11	0.002
_cons	-0.140	0.0850	-1.65	0.099
AR (2) test		0.322		
Hansen test		0.367		

*Note: * p<0.05, ** p<0.01, *** p<0.001*

Source: Authors' compilation

Our findings confirm the negative impact of corporate digital transformation on tax avoidance of Vietnamese listed companies. This indicates that digital transformation can significantly inhibit tax avoidance behavior by alleviating financial constraints and improving information transparency. The implementation of digital transformation, which involves the strategic utilization of information technology, seeks to enhance efficiency, productivity, and innovation within organizations. This may promote external supervision and resolve the issue of principal-agent conflicts. These findings align with previous studies by Tiantian et al. (2023) and Chen et al. (2024); while the results differ from the study by Lestari & Kholid (2024). The reason for the different results could be the difference in business characteristics of the two countries. Meanwhile, it can also be concluded from the study that state-owned companies are less likely to carry out tax avoidance behavior. This finding is consistent with Wu et al. (2013) and Nguyen & Phan (2017). Since tax is the most important source of government financing, state-owned enterprises benefit the government through tax payments. In addition, minimizing tax avoidance behaviors at these enterprises also encourages private corporations to contribute more to society through taxes.

Besides, the coefficients show that firm size (SIZE), profitability (ROE), inventory turnover ratio (INV), and fixed asset intensity (FAI) positively affect corporate tax avoidance. On the contrary, the results suggest the negative relationship between the level of tax avoidance and fixed asset efficiency (CAP), revenue growth rate (GROWTH), financial leverage ratio (LEV). All of the mentioned relationships are statistically significant at 1% and 5% level. Meanwhile, there is no evidence to conclude that the number of firm's active years (AGE) and audit quality (BIG4) affect the level of corporate tax avoidance.

5. Conclusions

This study analyzes the effect of digital transformation on corporate tax avoidance based on the data of non-financial companies in Vietnam from 2018 to 2023. We find out that enterprise digital transformation significantly inhibits tax avoidance behavior in Vietnam. This finding is consistent with the study of Tiantian et al. (2023), Xie et al. (2023). We also report that growth rate and state ownership negatively affect tax avoidance. In contrast, firm size, firm profitability, investment level in inventory, and fixed asset intensity significantly influence tax avoidance. Meanwhile, there is no relationship between audit quality, firm age, and tax avoidance.

Our research proposes innovative approaches to enhance the authenticity and reliability of tax revenues, which are fundamental pillars of economic development. In today's era of rapid digitalization, technological advancements present both opportunities and challenges for tax administration. By addressing the potential vulnerabilities associated with digital transactions, we can safeguard the government's ability to generate adequate revenue and provide essential public services. Therefore, this study proposes the following recommendations:

To the government: Given the inverse relationship between digital transformation and tax avoidance, that is, a high level of digital transformation significantly limits corporate tax avoidance behavior, the government needs to clearly understand the digital transformation landscape of enterprises and increase subsidies for digital technology innovation. This not only reduces the government's financial deficit but also promotes the development of the national economy. Some practical solutions the government can apply to encourage corporate digital transformation and enhance the effectiveness of tax administration include: (1) Identifying and sharing the obstacles faced by firms in executing tax compliance; (2) Adjust regulations on fines for tax avoidance behavior. Fines have to be more stringent and create extreme deterrents. Strictly and fairly handle illegal tax behaviors to prevent other firms from engaging in similar actions; (3) Plans for tax inspection need to be effectively developed so that the inspection process is conducted with a focus on corporations with high levels of risk and suspected violations. (4) The most effective management method is to analyze information about taxpayers. By implementing digitization of tax governance and applying digital technologies to create an automatic monitoring platform, authorities can grasp the business operation and tax compliance of enterprises. From there, specific solutions for each field of business are proposed.

To enterprises: Enterprises should concentrate on the inverse relationship between digital transformation and tax avoidance. By increasing their level of digital transformation, enterprises can not only optimize their business processes but also enhance the transparency of their financial information, thereby reducing the risk of tax non-compliance. In addition, proactive cooperation with tax authorities fosters a sustainable partnership and contributes to a transparent and equitable business environment. Simultaneously, enterprises must pay taxes accurately, comprehensively, and punctually following applicable tax regulations.

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Factors Influencing Digital Payment Adoption in the Northern Mountainous Area of Vietnam: An Integration of TAM and TPB

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Abstract

Digital payments have rapidly developed in Vietnam in recent years, especially after the COVID-19 pandemic. This study aims to assess the impact of factors on the adoption of digital payments, focusing on the Northern mountainous regions of Vietnam. By analyzing interview data from 509 respondents using structural equation modeling (SEM), we discovered that economic factors, including perceived usefulness, perceived ease of use, attitude, subjective norm, and perceived behavioral control, all positively and significantly influence users' adoption of digital payments. The findings of this study reveal that consumers experienced ease in conducting payment transactions and realized significant benefits from digital payment systems. The paper also explores the implications of these findings and proposes directions for future research.

Keywords*: C-TAM-TPB, digital payments, digital payments adoption, structural equation modeling*

1. Introduction

Transforming into a digital economy is both an objective and an urgent necessity for Vietnam as it continues to integrate more deeply into the international economy. A key focus of this transformation is the development of digital payments (DP), which drives advancements in the national population database, e-government, electronic public services, e-commerce, and non-cash payments. The recent rapid and widespread growth of digital payments is a testament to the success of this digital transformation. However, this development also presents challenges that must be addressed with suitable solutions moving forward (Dao, 2023). As one of the emerging economies in Southeast Asia, Vietnam is poised for significant growth in digital payments. In 2021, the total transaction value of digital payments in Vietnam was estimated at $15 billion, with an expected annual growth rate of 15.7% through 2025 (PWC Vietnam, 2021). This promising trajectory underscores the potential for further expansion and innovation in the digital payment landscape.

The digital economy and green economy have become key focal points in environmental policy and sustainable development discussions in recent years (Dat, 2023; Li et al., 2024). Digital transformation and the growth of the digital economy are long-term processes that focus more on practical application than on research (Ha, 2024; Hung, 2024). Policymakers have acknowledged the importance of prioritizing the development of the digital economy to achieve green growth. This approach aligns with the global consensus on addressing climate change through coordinated efforts rather than focusing solely on regional or local economic growth strategies, including those related to the digital economy (Dat, 2023; Lv & Chen, 2024). Vietnam should focus on developing its digital economy by fostering digital innovation and investing in robust digital infrastructure (Hung, 2024). Digital payments promote green growth globally and in Vietnam as part of digital transformation and the digital economy.

In recent years, digital payments have rapidly developed in Vietnam. The COVID-19 pandemic has accelerated this trend, with many Vietnamese consumers increasingly opting for digital payment methods. Digital payment provides greater convenience than traditional payment methods, enabling users to complete transactions quickly, from any location, at any time, and reduced costs (Teng & Khong, 2021; Zhang et al., 2023).

Several studies have explored the factors that influence the adoption of digital payments. These studies typically utilize well-established frameworks, including the Theory of Reason of Action (TRA) (L. T.

B. Diep, 2021), Technology Acceptance Model (TAM) (Davis,1989), the Unified Theory of Acceptance and Use of Technology (UTAUT), or its successor UTAUT2 (T. T. Linh & Huyen, 2024; Ramayanti et al., 2024; Venkatesh et al., 2012). Susanto et al. (2022) researched 597 digital payment articles and found that TAM theory was the most widely used to analyze factors influencing intent and even the continuity of using digital payments. However, TAM does not include social factors and behavioral control that many studies have shown to have a significant ability to influence users' actual use of new technology (Taylor & Todd, 1995a). Hence, they proposed a C-TAM-TPB model by combining TPB model (Theory of Planned Behavior) and TAM model (Chih Chung, 2013; Lee, 2009; Poon et al., 2024; Taylor & Todd, 1995b; Wu & Chen, 2005).

As far as we know, there is limited research on digital payment adoption (DPA) in Vietnam. N. N. Dung et al.(2021) combined UTAUT, TAM, and TPB in their research and indicated that mobility, accessibility, compatibility, convenience, and personal innovation have impacted the intention to use mobile payments. Owning accounts with financial intermediaries positively influenced the use of mobile payments by using the logit regression model (Son et al., 2020). ECM (Expectation Confirmation Model) and TAM were employed in the study, and the results indicate that trust, in the context of satisfaction, significantly influences the intention of Vietnamese customers to continue using e-wallets (Thao & Ngoc, 2022). T. T. Linh & Huyen (2024) used UTAUT2 extended and indicated that trust, perception of risk, performance expectancy, social influence, facilitating conditions, hedonic motivation, education, and household size significant impact on the intention to use digital payments among residents in the Northern mountainous

This study uses the C-TAM-TPB model by combining TPB and TAM models to evaluate factors influencing DPA in the Northern mountainous regions of Vietnam. The rest of the paper is structured as follows: Section 2 provides theoretical background. Section 3 outlines the method. Section 4 focuses on empirical results. Finally, section 5 presents the conclusion and some limitations.

2. Theoretical framework

Based on the C-TAM-TPB model and previous works, we utilize the integration of the TAM and TPB framework, incorporating five constructs: Perceived usefulness (PU), Perceived ease of use (PEU), Attitude (ATT), Perceived behavioral control (PBC), and Subjective norm (SN).

Perceived usefulness

Perceived usefulness, which reflects an individual's strong belief in the benefits of technology, is considered a critical factor in enhancing performance (Davis, 1989; Taylor & Todd, 1995a). Digital payment systems are deemed useful for customers when they offer substantial services. Despite previous unsatisfactory experiences, customers are likely to continue using digital payment methods if they find them beneficial (Bhattacherjee, 2001; V. Van Diep, 2017). Perceived usefulness is the most frequently utilized independent variable in prior research for assessing people's readiness to adopt DPs both at individual and organizational levels (Kabir et al., 2017). Therefore, we propose the following hypothesis:

H_1: Perceived usefulness (PU) positively influences attitudes (ATT) towards adopting digital payments.

H_4: Perceived usefulness (PU) positively influences user digital payments adoption (DPA).

Perceived ease of use

Perceived ease of use is defined as "the degree to which an individual believes that using a particular system would be free of effort" (Davis, 1989). Innovative technology systems that are perceived as easier to use and less complex are more likely to gain acceptance and be adopted by users. Digital payment systems are perceived as easy to use when users find them simple to understand, quick to learn, and straightforward to operate. As a result, perceived ease of use is recognized as a critical factor influencing users' acceptance and adoption of new technology (V. Van Diep, 2017; Kabir et al., 2017). Additionally, a more vital perception of ease of use can enhance consumer confidence in the expected benefits of using technological products (Daragmeh et al., 2021; Doanh et al., 2022). Accordingly, we propose the following hypothesis:

H_2: Perceived ease of use (PEU) positively influences attitudes (ATT) towards adopting digital payments.

H_3: Perceived ease of use (PEU) positively influences perceived usefulness (PU) towards adopting digital payments.

Attitude

Attitude refers to an individual's favorable or unfavorable feelings about engaging in a particular behavior (Davis, 1989; Taylor & Todd, 1995a). Additionally, a positive or negative attitude directly impacts the strength of behavioral beliefs regarding the anticipated significant outcomes (Wu & Chen, 2005). Therefore, it is more likely for customers to take action to use digital payments if they develop a positive opinion about the adoption of a digital payment method. In line with the above argument, we propose the following hypothesis:

H_5: Attitude (ATT) positively influences user digital payments adoption (DPA).

Perceived behavioral control

Perceived behavioral control represents an individual's perception of the ease or difficulty involved in carrying out a particular behavior. It relates to beliefs about the presence of factors that may either facilitate or obstruct the performance of the behavior (Ajzen, 1991, 2002; Rachmawati & Rahardi, 2023). In the context of digital payments, perceived behavioral control refers to a consumer's perception of having the necessary resources, knowledge, and opportunities to adopt a digital payment method. We propose the following hypothesis:

H_6: Perceived behavioral control (PBC) positively influences user digital payments adoption (DPA).

Subjective norm

Subjective norm refers to an individual's perception of social pressure to either engage in or refrain from a particular behavior (Ajzen, 1991). In other words, subjective norm relates to an individual's normative beliefs about the expectations of others (Rachmawati & Rahardi, 2023; Wu & Chen, 2005). In our study, subjective norm is defined as consumers' beliefs about the influence that someone important to them may have on their decision to adopt digital payment methods. Based on this, we propose the following hypothesis:

H7: Subjective norm (SN) positively influences user digital payments adoption (DPA).

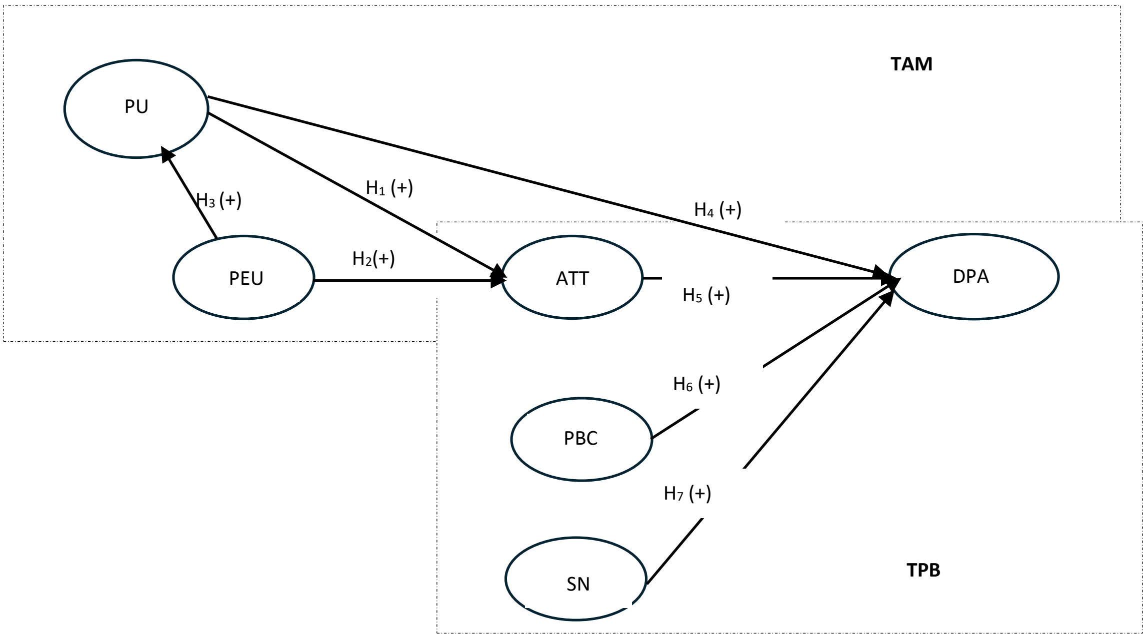

Figure 1: Conceptual framework

Source: Authors

3. Methods

3.1. Data collection

This study was conducted in two provinces in the mountainous region of northern Vietnam: Lang Son and Cao Bang. These provinces were chosen for their dynamic border trade and significant growth in tourism economies. Despite these economic activities, the adoption rate of digital payments among households remains limited. In Lang Son, around 47.37% of households use digital payments for paying electricity bills (M. Linh & Huyen, 2023) while in Cao Bang, this figure is about (K. Dung & Thu, 2019).

This study employed both quantitative and qualitative research methods in four phases to identify the factors influencing digital payment adoption in the Northern mountainous region of Vietnam. First, we developed scales based on theoretical foundations and relevant literature. Second, we consulted experts in fintech and e-commerce to validate the content of these scales. Third, we conducted a pilot test with 100 participants in Thai Nguyen and Cao Bang, refining the questionnaire based on their feedback. Finally, the official survey was conducted from December 2023 to January 2024 in Lang Son and Cao Bang provinces.

Sample size determination followed the guidelines of Hair et al. (2019), requiring a ratio of 20:1 for the six constructs in the study, necessitating a sample of at least 120. We surveyed 800 people (400 from each province), with residents receiving a project summary and consent form instructions before the interviews. Out of the 800 surveys administered, 509 met the criteria, yielding a response rate of 63.63%.

3.2. Sample demographics

Table 1 outlines the demographic characteristics of the survey respondents. The gender distribution shows that 42.6% of the respondents are male, while 57.4% are female. Most respondents are between 31 and 40 years old, making up 45% of the sample, with the 41 to 50-year-old age group being the next largest, comprising 28.1% (125 individuals). Regarding ethnicity, 78.2% belong to ethnic minorities, such as Tay and Nung, while the remaining respondents are from the Kinh group. Regarding education, most participants have completed college or university degrees, representing 47.3% of the sample, followed by high school graduates at 24.6%. The occupational data indicates that 55.4% of the respondents are workers employed away from home or are commune-level civil servants, while the remaining 44.6% are farmers.

Table 1: Sample demographics

Variables	Category	Frequency	Percent
Gender	Male	217	42.6
	Female	292	57.4
Age	Under 20	4	0.8
	21 – 30	87	17.1
	31 – 40	229	45.0
	41 – 50	143	28.1
	Over 50	46	9.0
Culture	Kinh	111	21.8
	Others	398	78.2
Educational level	None	13	2.6
	Primary school	36	7.1
	Secondary school	17	3.3
	High school	125	24.6
	Vocational School	29	5.7
	College, University	241	47.3
	Master	48	9.4
Job	Farmer	227	44.6
	Others	282	55.4

Source: Authors

3.3. Method estimation

We selected SEM as the analysis method for our study due to its robustness in theory testing, as highlighted by Steenkamp & Baumgartner (2000) SEM is particularly suitable for our research, which involves multi-dimensional constructs that are not directly observable but are instead measured through observable indicators. Given SEM's focus on construct operationalization, as discussed by Bagozzi (1994), it serves as an appropriate and effective approach for our investigation.

Before applying SEM, we followed the guidelines of Doanh et al. (2024) and Huy et al.(2024) by conducting exploratory factor analysis (EFA) to identify latent variables. Subsequently, we performed a confirmatory factor analysis (CFA), examining factor loadings, composite reliability (CR) indexes (Joreskog et al., 1971), and average variance extracted (AVE). This methodology, frequently cited in the literature, allows for a thorough assessment of our research constructs and ensures the validity and reliability of our findings.

4. Results

4.1. Measurement model

Before proceeding with SEM model testing to evaluate the hypotheses, we performed EFA and CFA to assess the constructs and confirm the reliability and validity of the measurement model. As shown in Table 2, the overall Cronbach's alpha is 0.929, which is well above the threshold of 0.6, and all observed variables have Cronbach's alpha coefficients of 0.925 or higher. The EFA results indicate that six variables were extracted from 26 observed factors, with an eigenvalue of 1.126 (>1) and a variance explained of 69.67%. Additionally, the factor loadings of the items ranged from 0.678 to 0.841, aligning with the existing literature. The KMO test yielded a value of 0.915, satisfying the criterion of 0.5 < KMO < 1, confirming the suitability of EFA for our data. Furthermore, the Chi-square statistic from Bartlett's test was 7683.645, with a p-value of 0.000, indicating that the data is appropriate and reliable for the EFA method.

Table 2: The results of Cronbach's alpha and Exploratory Factor Analysis

Variable	Cronbach's alpha (CA)	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
PU1	0.927						0.810
PU2	0.927						0.813
PU3	0.926						0.785
PEU1	0.928		0.715				
PEU2	0.927		0.728				
PEU3	0.928		0.786				
PEU4	0.928		0.769				
PEU5	0.927		0.735				
ATT1	0.925					0.680	
ATT 2	0.925					0.769	
ATT 3	0.926					0.799	
ATT 4	0.925					0.694	
SN1	0.925	0.752					
SN2	0.925	0.755					
SN3	0.926	0.709					
SN4	0.925	0.779					
SN5	0.925	0.766					
SN6	0.925	0.678					
PBC1	0.925				0.670		

Variable	Cronbach's alpha (CA)	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
PBC2	0.925				0.715		
PBC3	0.926				0.767		
PBC4	0.925				0.758		
DPA1	0.925			0.728			
DPA2	0.925			0.841			
DPA3	0.926			0.810			
DPA4	0.926			0.779			

KMO= 0.915 the Bartlett test $\chi 2$ = 7683.645, p-value = 0.000

Source: Authors

CFA enables testing the validity and accuracy of models built on theoretical foundations and empirical data. We evaluated the goodness-of-fit of the measurement model using several tests, including the Chi-square test ($\chi 2$), Comparative fit index (CFI), Tucker–Lewis Index (TLI), root mean squared error of approximation (RMSEA), composite reliability (CR) and average variance extracted (AVE). As shown in Table 3, the composite reliability (CR) of latent variables exceeds 0.840, and the AVE values range from 0.515 to 0.686. Additionally, the results demonstrate that the measurement model achieves favorable fit indices, with ($\chi 2$/df = 2.301, CFI = 0.954, TLI = 0.944, RMSEA = 0.05). These findings provide strong evidence supporting the suitability, reliability, and validity of our proposed model, indicating that the data exhibit a good model fit.

Table 3: Construct reliability and convergent validity

Items	Coef.	OIM Std. Err	P-value	Composite Reliability (CR)	Average Variance Extracted (AVE)
Perceived Usefulness- PU				**0.840**	**0.637**
PU1	0.755	0.025	0.000		
PU2	0.809	0.022	0.000		
PU3	0.824	0.021	0.000		
Perceived Ease of Use-PEU				**0.840**	**0.515**
PEU1	0.733	0.039	0.000		
PEU2	0.753	0.038	0.000		
PEU3	0.773	0.033	0.000		
PEU4	0.741	0.034	0.000		
PEU5	0.487	0.048	0.000		
Attitude- ATT				**0.864**	**0.614**
ATT1	0.755	0.024	0.000		
ATT2	0.801	0.021	0.000		
ATT3	0.767	0.024	0.000		
ATT4	0.766	0.023	0.000		
Subjective Norm- SN				**0.859**	**0.604**
SN1	0.787	0.022	0.000		
SN2	0.770	0.021	0.000		
SN3	0.717	0.024	0.000		
SN4	0.817	0.019	0.000		

Items	Coef.	OIM Std. Err	P-value	Composite Reliability (CR)	Average Variance Extracted (AVE)
SN5	0.799	0.018	0.000		
SN6	0.771	0.023	0.000		
Perceived Behavioral Control- PBC				**0.864**	**0.614**
PBC1	0.784	0.026	0.000		
PBC2	0.799	0.025	0.000		
PBC3	0.777	0.023	0.000		
PBC4	0.805	0.022	0.000		
Digital Payments Adoption - DPA				**0.897**	**0.686**
DPA1	0.893	0.041	0.000		
DPA2	0.853	0.017	0.000		
DPA3	0.829	0.019	0.000		
DPA4	0.824	0.019	0.000		

LR test of model vs. saturated: chi2 (267) = 614.26   Prob > chi2 = 0.0000

Source: Authors

4.2. Structural equation model

Figure 2 presents the model's estimation results using the SEM method. The assessment revealed favorable fit index values: $\chi2/df = 4.449$, CFI = 0.874; TLI = 0.851, RMSEA = 0.08. These results indicate that the empirical findings are reliable and valid.

As a result, all hypotheses are positive and statistically significant at the 1% level. It means that all hypotheses are supported.

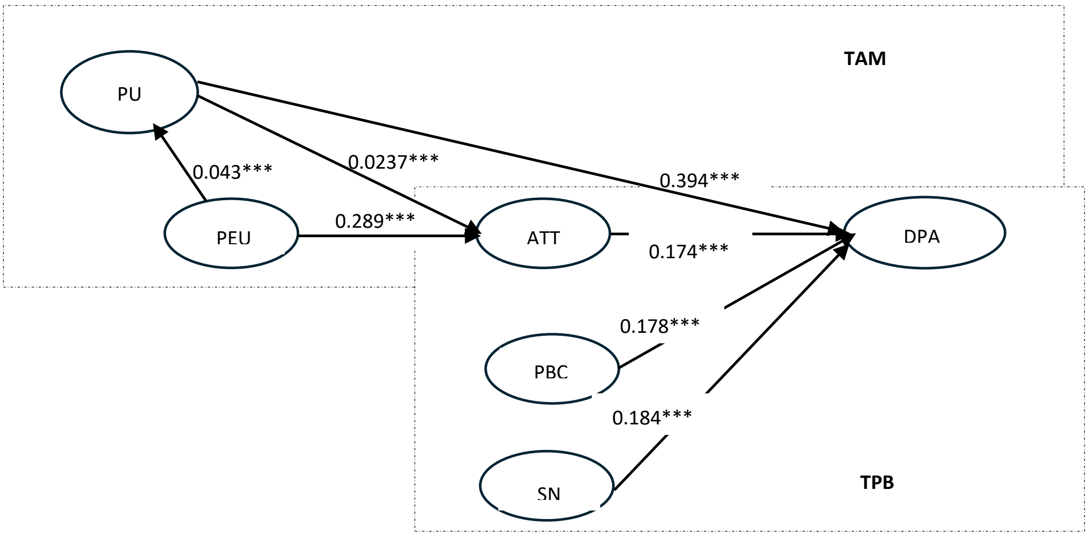

Figure 2: The results of the structural equation model

Source: Authors

5. Conclusion

This study aims to investigate the factors influencing digital payment adoption in the Northern mountainous area of Vietnam. The empirical results from the SEM model reveal that economic factors, including perceived usefulness, perceived ease of use, attitude, subjective norm, and perceived behavioral control, all positively and significantly influence users' adoption of digital payments.

The findings of H1 and H2 align with previous studies, showing that perceived usefulness and perceived ease of use positively and significantly influence users' attitudes toward using digital payment (Ariffin et al., 2021; Mabkhot et al., 2023). The findings of this study indicate that consumers found it easy to conduct payment transactions using a digital payment system. The system not only streamlined their payment processing but also enhanced their transaction efficiency, leading to a positive attitude toward adopting digital payments.

Similarly, the finding of H3 is consistent with previous research, which demonstrated that perceived ease of use positively and significantly influences perceived usefulness at the 1% level (Aji et al., 2020; Ranpariya & Joshi, 2024; Siagian et al., 2022). It proved that perceived ease of use increases the perceived usefulness of adopting digital payments. Therefore, service providers should focus on further developing and improving their payment system to be simpler to understand, quick to learn, and straightforward to operate digital payment services.

Our results also show the positive influence of perceived usefulness at the 1% significance level on DPA, thereby supporting H4. Conclusively, the results obtained are supported by the results of previous studies (Aji et al., 2020; Chawla & Joshi, 2019; Nguyen & Ao, 2022; Ranpariya & Joshi, 2024). This means that when consumers achieve significant benefits from digital payment systems, they will trust DP more and continue to use it. Therefore, service providers should focus on further developing and improving the quality of DP to increase customers' perception of its usefulness. This will help increase the number of users adopting DPs.

Attitude (ATT) was also determined to positively impact the intention to use DP at the 1% significance level; hence, hypothesis H5 is supported. People are aware that DP may be riskier than paying in cash. This study is also in accordance with the results of research by Ariffin & Lim (2020); Ayudya & Wibowo (2018); Chawla & Joshi (2019); Ranpariya & Joshi (2024). It means that customers have a positive opinion about adopting digital payment methods.

Perceived behavioral control (PBC) is supposed to positively affect the use of DP at the 1% level. This hypothesis is supported by the value of the standard regression coefficient (0.178). Therefore, the acceptance of hypothesis H6 has been verified. This finding reveals that consumers nowadays have enough resources, knowledge, and opportunities to adopt a digital payment method. This result was consistent with the results of Ariffin et al. (2021); Ariffin & Lim (2020); Ayudya & Wibowo (2018); Mabkhot et al. (2023).

Furthermore, subjective norms also positively impact users' adoption of digital payment at the 1% significance level. The result aligns with the viewpoints of Aji et al. (2020); Ariffin et al. (2021); Jusoh & Jing (2019). This insight demonstrates that people's willingness to adopt digital payments as a new mode of transaction is significantly influenced by their peers' opinions and behaviors. Reliable information from trusted sources like relatives, neighbors, or friends boosts consumers' trust in digital payment methods, leading to a stronger intention to adopt them. Therefore, it is essential to continue expanding the dissemination of information and communication regarding the practical benefits of digital payments and cashless transactions.

Based on the results, it can be concluded that when economic factors significantly positively impact digital payment adoption, the number of users utilizing digital payments is likely to increase. Consequently, this growth in digital payment usage will contribute to advancing the digital economy and support green growth.

Although this study offers valuable insights into the current literature, it is important to recognize certain limitations. The research was confined to respondents from the Northern mountainous region of Vietnam, which may not fully represent the broader population due to the specific research area's constraints and the limited sample size. Future studies should aim to include a broader range of factors in the model and conduct surveys across different regions to gain a more comprehensive and accurate understanding of people's decisions to adopt DP methods. This study did not explore the role of satisfaction as a mediator. Future research could investigate satisfaction as a mediating variable to validate its contribution to the existing model. In addition, whether adopting digital payments increases users' income has not been analyzed. Hence, future research should focus on this issue.

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A Study on Factors Influencing the Acceptance of the VNID Electronic Identification Application among Generation Z in Hanoi

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Abstract

The deployment of VNeID - Vietnam electronic identification is a vital component of the national digital transformation strategy aimed at achieving e-Government and progressively achieving sustainable development goals. Despite its importance, the current adoption rate of VNeID remains suboptimal. To address this issue, it is crucial to conduct research to identify and propose solutions that enhance user adoption, thereby optimizing the effectiveness of VNeID in the context of ongoing digital transformation. This study specifically examines the acceptance of VNeID among Generation Z in Hanoi, utilizing data collected from 350 young individuals. Various analyses, including Cronbach's Alpha test, exploratory factor analysis (EFA), and multiple linear regression analysis, were performed using SPSS 27 software. The findings identify four key factors that significantly influence the intention to use VNeID, ranked as follows: (1) Perceived Usefulness, (2) Perceived Security, (3) Attitude, and (4) Perceived Ease of Use. Based on these results, the study suggests targeted strategies to increase public acceptance of VNeID.

Keywords: *Digital transformation, generation Z, sustainable development, technology acceptance model* (*TAM), VNeID*

1. Introduction

The application of information technology and the internet has led to the widespread construction and implementation of e-Government in many countries. Consequently, this brings significant benefits to all relevant parties. It enhances the quality and efficiency of public administrative services, increases transparency, reduces corruption, promotes e-democracy, and creates an open administrative environment focused on citizens (Zahid et al., 2022; Zhang & Zhu, 2021). Simultaneously, it also minimizes costs and conserves resources for agencies, entities, and individuals, thereby contributing to achieving sustainable development goals. Acknowledging these benefits, the Government of Vietnam has swiftly introduced policies and initiatives to strengthen the application of information technology in enhancing e-Government. Specifically, on June 15, 2021, the Government issued Decision No. 942/QD-TTg on approving strategy for development of e-Government towards digital Government for 2021 - 2025 with orientations towards 2030. To realize this strategy, it is crucial not only to modernize Government infrastructure and refine the legal frameworks but also to develop electronic citizenship, thereby digitizing individual citizens and society as a whole. Electronic identification serves as the initial step in the citizen digitization process and is becoming an indispensable component for all nations, which are top-prioritized in their journey toward e-Government. Because an online society necessitates an electronic identification system to seamlessly and securely provide online services. In Vietnam, VNeID - Vietnam electronic identification, was officially launched on July 18, 2022. However, its successful implementation faces several significant challenges. For instance, despite the initial high activation rates, the actual utilization among users remains relatively suboptimal compared to the number of activated accounts. At the preliminary conference summarizing 01 year of implementing the Prime Minister's direction on removing "bottlenecks" of Project 06, chaired by The Prime Minister on the morning of June 10, 2024, according to the report presented, the Ministry of

Public Security issued over 86 million chip-embedded citizen identity cards and collected more than 75,16 million electronic identification profiles, activating 53,88 million accounts (the activation rate among the total collected profiles reached 71,68%). Furthermore, the Ministry of Public Security has integrated and utilized electronic identification accounts for logging into the National Public Service Portal and applications of various ministries and branches, with an average of approximately 150,000 logins per day since the beginning of 2024. However, the utilization rate of electronic identification accounts remains relatively suboptimal (in comparison to the number of activated accounts).

According to AlAwadhi & Morris (2008), the success of implementing online public services hinges not only on Government support but also significantly on citizens' willingness to accept and adopt these services. Therefore, it is essential to clearly identify the factors influencing public acceptance of VNeID, and contributing to its successful deployment. Numerous empirical studies have broadly examined the acceptance of online public services (Ali & Anwar, 2021; Almaiah & Nasereddin, 2020; Chen & Aklikokou, 2020; Mensah, 2020; Nguyen & Tran, 2022; Nguyen Trong et al., 2022; Nguyen et al., 2023; Thi Uyen Nguyen et al., 2024; Zahid & Haji Din, 2019); similarly, studies specifically focused on electronic identification (Göransson, 2018; Liesbrock & Sneiders, 2023; Stepančič & Blažič, 2018; Tsap et al., 2020; Yee Yen et al., 2022). However, research focusing on the acceptance of VNeID in Vietnam remains limited.

Generation Z - individuals born between 1997 and 2012 - are often regarded as "digital citizens" due to being the generation exposed to the internet and digital devices from an early age (Turner, 2015). In today's digital era, they are seen as highly tech-savvy and more receptive to new technologies compared to earlier generations (Dadvari & Do, 2019). Additionally, Generation Z currently makes up approximately one-quarter of the global population, with around 2,6 billion individuals. According to the General Statistics Office of Vietnam, the estimated number of Generation Z members in Vietnam will reach approximately 15 million by 2025, representing roughly about 25% of the income-earning working-age population. Therefore, Generation Z in Vietnam is anticipated to play a pivotal role in the nation's digital transformation. They will be at the forefront of adopting VNeID and spreading its use to other generations, supporting their implementation and utilization.

Therefore, based on the aforementioned context, the study is conducted to identify the factors influencing the acceptance of VNeID, specifically among Generation Z in Hanoi. This research provides essential information for policymakers, researchers, and proposes solutions to promote public acceptance of VNeID.

According to Decree No. 43/2011/ND-CP dated June 13, 2011 of the Government on provision of online information and public services on websites or web portals of state agencies, public administrative service means "a not-for-profit service related to law enforcement in the domains managed by a state agency, which is provided by that state agency to organizations and individuals in the form of legally valid papers". Online public service is "a public administrative service or another service provided by a state agency to organizations and individuals in a network environment". Online public services provide a new way to carry out administrative procedures by using information technology, with the internet as a powerful tool that helps speed up processing, resulting in higher efficiency and effectiveness (Kane et al., 2009). Consequently, this reduces costs as well as time in transactions between the Government and citizens, organizations (Ebbers et al., 2008). The Government has deployed and provided several online public services, including VNeID. Based on Decree No. 59/2022/ND-CP dated September 5, 2022 of Government, VNeID refers to "an application available on digital devices created and developed by the Ministry of Public Security to enable access to e-identification and e-authentication services during the process of handling of administrative procedures, public administrative services and other transactions in cyberspace; help promote facilities and amenities necessary for agencies, entities and individuals." Therefore, with an electronic identification account, citizens can conduct transactions in the digital environment, ensuring reliability, accuracy, speed, simplicity, cost-effectiveness, and efficiency compared to before. The main purposes of VNeID include: serving electronic identification and electronic authentication activities in the resolution of administrative procedures, public administrative services, and other transactions in the digital environment and developing utilities to serve Government agencies, organizations, and individuals.

Individual electronic identification accounts are divided into two levels with different information and usage values. Level 1 electronic identification accounts provide basic information about citizens, such as personal identification number, full name, date of birth, and gender for transactions requiring personal information. Level 2 electronic identification accounts are equivalent to using the citizen identity card in transactions that require presenting the citizen identity card. Electronic identification accounts provide information from citizens' documents that have been synchronized into the account for authorized agencies and organizations to verify. When using a Level 2 electronic identification account in electronic transactions, it is equivalent to presenting documents to prove the integrated information in the electronic identification account. As a result, citizens can minimize carrying multiple documents when conducting administrative transactions.

2. Literature review and Hypothesis development

The Technology Acceptance Model (TAM), developed by Davis (1989), is widely used to explain and predict user technology acceptance. It is an extension of the Theory of Reasoned Action (TRA) proposed by Fishbein & Ajzen (1977), which explains and predicts human behavior in specific situations. According to Davis (1989), user acceptance is defined as the intention to use and apply technology. In this framework, users can be either potential or actual consumers who engage with the technology interface to gain benefits from its use. TAM has been widely tested and accepted in information technology studies (Venkatesh, 2000) and is regarded as a valuable predictive model (Samaradiwakara & Gunawardena, 2014). TAM proposes that the acceptance of new information systems can be predicted through "Behavioral Intention To Use" influenced by "User's Attitude Toward Usage", along with two critical factors: "Perceived Ease of Use" and "Perceived Usefulness".

TAM is inherited and applied by the author as the theoretical foundation for this research model. As mentioned, TAM is well-suited for research related to technology acceptance and usage. VNeID is also software operating on mobile devices, utilizing information technology in its functioning. Furthermore, various empirical studies have employed TAM with components "Attitude", "Perceived Usefulness" and "Perceived Ease of Use" as direct precursors to technology acceptance and adoption in the field of online public services (Ali & Anwar, 2021; Amanbek et al., 2020; Chen & Aklikokou, 2020; Eid et al., 2021; Mensah, 2020; Sijabat, 2020; Sulistyowati et al., 2021). Therefore, based on the TAM, incorporating two additional factors inherited from preliminary studies: "Subjective Norm" (Almaiah & Nasereddin, 2020; Zahid & Haji Din, 2019) and "Perceived Security" (Bhuvana & Vasantha, 2021; Tsap et al., 2020), the proposed research model is as follows:

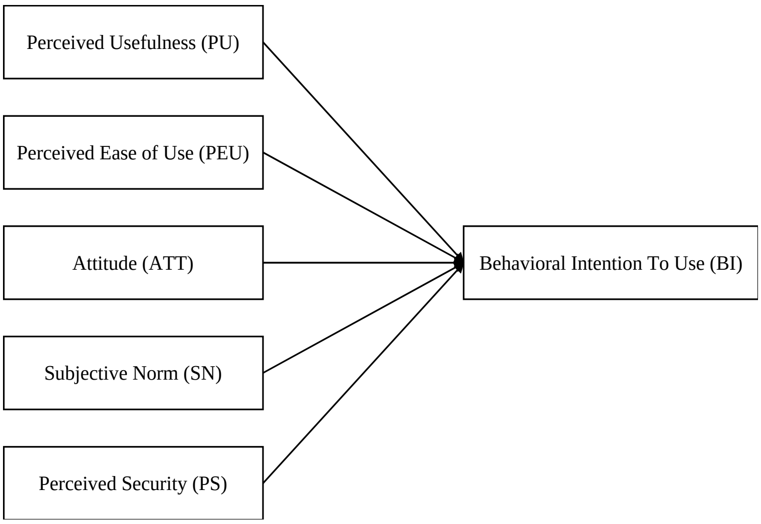

Figure 1: Proposed research model

Source: Proposed by research team

Attitude (ATT): Defined as "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" (Ajzen, 1991). Accordingly, individuals will use a system when they have a positive attitude, and conversely, they will reject the system if they have a negative attitude toward its use (Thompson et al., 1991). In the context of online public service, numerous studies have demonstrated that users' attitude positively influence their behavioral intention to use (Ali & Anwar, 2021; Bhuvana & Vasantha, 2021; Eid et al., 2021; Nguyen et al., 2023; Susanto et al., 2017; Xin et al., 2022).

H1: Attitude toward using VNeID has a positive influence on behavioral intention to use VNeID.

Perceived Ease of Use (PEU): Refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Various studies in the field of online public services have indicated that perceived ease of use positively influences users' behavioral intention to use (Ali & Anwar, 2021; Chen & Aklikokou, 2020; Eid et al., 2021; Munyoka, 2020; Sulistyowati et al., 2021).

H2: Perceived ease of use has a positive influence on behavioral intention to use VNeID.

Perceived Usefulness (PU): Defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Perceived usefulness has been found to have a positive influence on behavioral intention to use in the field of online public services (Ali & Anwar, 2021; Chen & Aklikokou, 2020; Eid et al., 2021; Mensah, 2020; Sijabat, 2020; Thi Uyen Nguyen et al., 2024).

H3: Perceived usefulness has a positive influence on behavioral intention to use VNeID.

Perceived Security (PS): Refers to "the degree of customer's belief that the application is safe from interference and ensures protection of personal information shared over it" (Ismail Hussien & Abd El Aziz, 2013). Previous studies have affirmed that perceived security positively influences the behavioral intention to use online public services (Bhuvana & Vasantha, 2021; Maharaj & Munyoka, 2019; Shankar & Kumari, 2019; Tsap et al., 2020)

H4: Perceived security has a positive influence on behavioral intention to use VNeID.

Subjective Norm (SN): Refers to "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1985). Factors related to subjective norms include opinions from family and friends (Davis, 1989), community opinions, and Government policies (Forsythe & Shi, 2003). Empirical studies have demonstrated that subjective norm has a positive influence on usage behavioral intention to use in the field of online public services (Afrizal & Wallang, 2021; Almaiah & Nasereddin, 2020; Alryalat et al., 2020; Susanto et al., 2017; Zahid & Haji Din, 2019).

H5: Subjective norm has a positive influence on behavioral intention to use VNeID.

Behavioral Intention To Use (BI): According to Fishbein and Ajzen (1977), "intention is thus assumed to be the immediate antecedent of behavior, and to guide behavior in a controlled and deliberate fashion".

3. Methods

The study employed a mixed-methods approach, combining both qualitative and quantitative research methods. The qualitative research method was utilized to synthesize and analyze theoretical issues and previous relevant studies. The results of the qualitative study aided the authors in constructing a research model and exploring the relationships among variables in the model. Subsequently, measurement scales were developed and used to design a questionnaire. The final measurement scale, after adjustments, included 15 observed variables, designed on a 5-point Likert scale ranging from "strongly disagree" (1) to "disagree" (2), "neutral" (3), "agree" (4), and "strongly agree" (5). The quantitative phase was conducted with a sample size of 350 participants (N = 350), following the 5:1 ratio standard recommended by Hair et al. (2006), which suggests that each measured variable should have at least five observations and the total number of observations is not fewer than 100. The survey questionnaire included 15 observed variables, resulting in a minimum sample size of 15 x 5 = 75.

Participants in the survey were individuals from Generation Z (born between 1997 and 2012) residing in Hanoi. The authors employed random sampling for participant selection. Data was collected through an online survey. The survey questionnaire was developed using Google Forms and distributed through various channels, including email (Gmail), online social networks (Facebook, Instagram), and online communication applications (Zalo, Telegram). The survey was conducted from February to June 2024. Initially, a total of 372 survey responses were collected. After data cleaning, 350 valid responses remained. SPSS 27 software was used to determine the influence of the variables on behavioral intention to use

VNeID. Analytical procedures included descriptive statistics, Cronbach's Alpha test, exploratory factor analysis (EFA), multiple linear regression analysis, One-way ANOVA, and Independent-Samples T Test.

4. Results

4.1. Descriptive statistics

Characteristics of the study sample is indicated in Table 1.

Table 1: Characteristics of the study sample

Demographic Variables	Description	Frequency	Percentage
Gender	Male	86	24,6%
	Female	261	74,6%
	Others	3	0,9%
Age	1997 - 2005	329	94%
	2006 - 2012	21	6%
Educational Level	Secondary School	4	1,1%
	High School/ Vocational School	15	4,3%
	University/ College	322	92,0%
	Postgraduate	9	2,6%
Occupation	Students	314	89,7%
	Office Workers	29	8,3%
	Others	7	2,0%
Hometown	Hanoi City	115	32,9%
	Other Provinces/ Cities	235	67,1%

Source: Research team

4.2. Reliability analysis

A reliability analysis was performed using Cronbach's Alpha to assess the internal consistency of the research constructs. The results indicated that Cronbach's Alpha values consistently exceeded 0,6 (Hair et al., 2010), and corrected item-total correlation exceeded 0,3 (Cristobal et al., 2007). These findings indicate that the scales exhibit satisfactory internal consistency and reliability.

Table 2: Reliability analysis results

Variable Code	Variable Name	Descriptive Statistics Of Observed Variables	
		Cronbach's Alpha	Corrected Item-Total Correlation
Behavioral Intention To Use (BI)	BI1	0,783	0,628
	BI2		0,702
	BI3		0,548
Attitude (ATT)	ATT1	0,864	0,756
	ATT2		0,694
	ATT3		0,779
Perceived Usefulness (PU)	PU1	0,857	0,763
	PU2		0,718
	PU3		0,713
Perceived Ease of Use (PEU)	PEU1	0,841	0,661
	PEU2		0,758
	PEU3		0,700
Perceived Security (PS)	PS1	0,835	0,683
	PS2		0,731
	PS3		0,677
Subjective Norm (SN)	SN1	0,817	0,635
	SN2		0,685
	SN3		0,692

Source: Research team

4.3. Exploratory factor analysis (EFA)

Exploratory factor analysis with independent variables

EFA was conducted on the five independent variables. The results are as follows: KMO = 0,817 (0,5 < KMO < 1), sig. Bartlett's Test = 0,000 (< 0,05), indicating that EFA is appropriate. The fifteen observed variables converged into five factors (consistent with the theoretical model). The Eigenvalue = 1,067 (> 1). The total variance explained = 77,031% (> 50%), meaning these five factors accounted for 77,031% of the data variation among the 15 observed variables included in the EFA. All observed variables had factor coefficients greater than 0,5 (Hair et al., 2010). Therefore, all variables were retained in the model.

Table 3: Exploratory factor analysis results

Observed Variable	Component				
	1	2	3	4	5
ATT1	0,899				
ATT3	0,897				
ATT2	0,851				
PU1		0,858			
PU2		0,826			
PU3		0,764			
PS3			0,867		
PS2			0,834		
PS1			0,754		
PEU2				0,881	
PEU3				0,823	
PEU1				0,760	
SN3					0,873
SN2					0,851
SN1					0,801
KMO = 0,817					
Eigenvaluse = 1,067					
Total variance explained = 77,031%					

Source: Research team

Exploratory factor analysis with dependent variables

The results of the analysis extracted one dependent variable representing three observed variables in the measurement of the intention to use VNeID. KMO = 0,673 (0,5 < KMO < 1), and sig. Bartlett's Test = 0,000 (< 0,05), indicating that the EFA was appropriate. The Eigenvalues = 2,099 (> 1). The total variance explained = 69,972% (> 50%), meaning that this factor accounted for 69,973% of the data variation among the three observed variables included in the EFA.

Therefore, the initial research model, with results from Cronbach Alpha reliability analysis and exploratory factor analysis (EFA), indicated that the five independent factors and the dependent factors - intention to use all met the requirements and had statistical significance.

4.4. Multiple linear regression analysis

(1) Pearson's correlation analysis: Between the five independent variables (ATT, PU, PEU, PS, SN) and the dependent variable (BI), all correlations had sig. = 0,000 (< 0,05) (Field, 2009). Therefore, all five independent variables are significantly correlated with the dependent variable BI.

(2) Model evaluation and suitability test: Adjusted R-Squared = 0,520 ≠ 0, indicating a relatively high fit for the research model. In other words, the independent variables in the model explain 52% of the issue or 52% of the intention to use VNeID among Generation Z in Hanoi. Durbin-Watson = 1,767, falling within the range of 1,5 to 2,5 (Yahua, 2011), indicating no violation of the assumption of first-order autocorrelation.

(3) Multicollinearity test: As shown in Table 4, the variables ATT, PU, PEU, and PS all have sig. < 0,05, indicating statistical significance and an impact on the dependent variable BI. The regression coefficients for these independent variables are positive, suggesting a positive influence on the dependent variable. However, the variable SN has sig. = 0,075 (> 0,05), indicating no influence on the dependent variable BI.

The variance inflation factors (VIF) values for all variables were less than 2 (Hair et al., 2006), indicating that the model did not exhibit multicollinearity. Among the factors influencing the acceptance of VNeID among Generation Z in Hanoi, the variable “Perceived Usefulness” (PU) had the highest impact (β = 0,438), followed by the variable “Perceived Security” (PS) (β = 0,226), then “Attitude” (ATT) (β = 0,136), and finally “Perceived Ease of Use” (PEU) (β = 0,135). Thus, the order of influence from highest to lowest is as follows: PU > PS > ATT > PEU.

Based on the regression coefficients, we can formulate the standardized regression equation as follows:

BI = 0,438*PU + 0,226*PS + 0,136*ATT + 0,135*PEU + ε

Table 4: Multiple linear regression analysis results

Model	B	Standardized Coefficients Beta	t	Sig.	VIF
(Constant)	0,320		1,374	0,170	
ATT	0,146	0,136	3,612	0,000	1,037
PU	0,403	0,438	9,249	0,000	1,629
PEU	0,121	0,135	3,024	0,003	1,456
PS	0,204	0,226	5,035	0,000	1,463
SN	0,072	0,070	1,788	0,075	1,128
Adjusted R-Squared = 0,520					
Durbin-Watson = 1,767					

Source: Research team

Independent-Samples T-Test and One-way ANOVA

The Independent-Sample T Test and the One-way ANOVA test were used to analyze if there are differences in behavioral intention to use VNeID attribute hometown, gender, age group, educational level, or occupation. The significance values (Sig.) for both T-Test and ANOVA are all greater than 0,05 (Table 5). Therefore, we conclude that there is no significant difference in the intention to use VNeID among individuals within Generation Z in Hanoi based on factors such as hometown, gender, age, educational level, or occupation.

Table 5: Independent-Samples T Test and One-way ANOVA results

Characteristics	Levene Statistic (Sig.)	T-Test (Sig.)/ Anova (Sig.)	Conclusion
Hometown	0,677	0,600	No difference between groups
Gender	0,770	0,443	No difference between groups
Age	0,589	0,579	No difference between groups
Education Level	0,795	0,833	No difference between groups
Occupation	0,948	0,203	No difference between groups

Source: Research team

5. Conclusion

The research developed a model comprising five factors: “Attitude”, “Perceived Ease of Use”, “Perceived Usefulness”, “Perceived Security”, and “Subjective Norm”, which influence the acceptance of VNeID among Generation Z in Hanoi. The results indicate that four factors “Attitude” “Perceived Ease of Use”, “Perceived Usefulness”, and “Perceived Security” have a positive influence on the acceptance of VNeID among Generation Z in Hanoi, whereas “Subjective Norm” does not have an influence. Among these factors, “Perceived Usefulness” exerts the strongest influence on user acceptance, followed by “Perceived Security”, “Attitude”, and “Perceived Ease of Use”. Furthermore, One-way ANOVA and Independent-Samples T Test revealed no significant differences in the intention to use VNeID among Generation Z in Hanoi across different genders, ages, education levels, occupations, or hometowns.

Based on the research findings, several targeted solutions are proposed to enhance the public acceptance and utilization of VNeID. These solutions aim to support Vietnam’s ongoing digital transformation efforts and contribute to achieving sustainable development goals. Key recommendations include:

Improving User Attitude: Fostering a positive user experience through enhanced support and direct assistance, ensuring users feel confident and valued when interacting with VNeID.

Enhancing Perceived Usefulness: Continuously developing and upgrading VNeID features to maximize user benefits and meet the evolving needs of the digital environment.

Improving Usability: Adapting the application to suit all user groups, including those less proficient with technology, and providing comprehensive education and support to bridge any knowledge gaps.

Ensuring Security: Strengthening communication about VNeID's security features and conducting widespread campaigns to reshape public perceptions and habits towards adopting new technologies.

This study provides critical insights into the acceptance of VNeID among Generation Z in Hanoi, highlighting the need for targeted strategies to enhance user adoption and secure digital transformation, foster sustainable development in Vietnam. However, the study still has some limitations, such as a relatively small sample size and a focus solely on observations within the geographical boundaries of Hanoi. Consequently, future research could expand the sample size and research scope to enhance the generalizability of the research model.

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Solutions to Green Banking Development in the context of Digital Transformation in Vietnam

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Abstract

Sustainable development is a top priority for many economies in the world, including Vietnam. Vietnam's sustainable development strategy was issued by the Prime Minister in Decision No. 153/2004/QD-TTg dated August 17, 2004 and the National Strategy for Sustainable Development for the 2011-2020 period in Decision No. 432/QD-TTg dated April 12, 2012; accordingly, the goal that Vietnam is aiming for is sustainable and effective growth, coupled with progress, social equity, protection of resources and the environment, etc. In the context of digital transformation today becoming an inevitable trend, a development priority of most countries in the world, in Vietnam, digital transformation is considered one of the main pillars in the 10-year socio-economic development strategy 2021-2030 of the 13th National Congress; In which, digital transformation of the banking sector is identified as one of the 8 priority areas according to Decision 749/QD-TTg dated June 3, 2020 of the Prime Minister approving the Program "National digital transformation to 2025, orientation to 2030". To ensure the implementation of these dual goals, many mechanisms and policies have been issued in the recent period, including policies and guidelines to promote the development of the banking and finance sector towards green, clean and sustainable trends. The Scientific Articles will focus on assessing and analyzing the current status of green banking development in the banking system in Vietnam, in the context of digital transformation becoming a dominant trend in the world and Vietnam, thereby proposing solutions for green banking development in the context of digital transformation in Vietnam to promote the implementation of national digital transformation goals and sustainable development.

Keywords: *Digital transformation, green banking*

1. Introduction

In the context of globalization and modernization today, commercial banks have constantly changed their business models to reach more target customer groups. Banks develop advanced and modern technology services, aiming to meet the development trends of the times and the needs of customers for innovation. The emergence of the green banking system has "promoted the economic growth and development of each country, while maintaining and developing natural capital; minimizing pollution and environmental degradation; curbing greenhouse gas emissions, providing more jobs for society". Green banking also helps improve the quality of growth, production structure, and consumption towards sustainability, reducing greenhouse gas emissions, enhancing resilience to climate change, and effectively using resources, aiming at the goal of social equity.

Green banking is one of the core factors that has opened up many new opportunities for Vietnamese commercial banks to go further and penetrate international markets, helping to enhance the sustainable competitiveness of domestic banks with foreign commercial banks operating in the Vietnamese financial market. Kaeufer (2010) believes that Vietnam is at level 3 in green banking development "Systemic business operations", Vietnam needs to make more efforts to "upgrade" to level 4 "Initiative for strategic ecosystem" and level 5 "Initiative for proactive ecosystem". Green banking has been a priority development strategy of commercial banks in Vietnam in recent years, however, the development and growth of this model in the domestic market is still low compared to green banking systems in the world.

Green banking is still a relatively new concept in Vietnam, so it also faces some limitations in terms of scientific significance. Some authors focus on qualitative research and basic analysis of factors affecting the construction and development of green banking. However, studies related to the level of awareness and understanding mainly analyze bank employees or customers of banks. Meanwhile, customers are an important resource for the development of the future green banking system in Vietnam, which is very little research. Developing green banking in the context of digital transformation is an important and practical issue for the current Vietnamese banking system, attracting the attention of the State, Government, businesses as well as people. In order to fill the research gap, the results of this research will help educational institutions and bank administrators gain a closer look and plan a strategy to build a sustainable green bank, in line with the digital transformation strategy in Vietnam.

In the world, green banking has been mentioned a lot in the past 10 years and has become popular. In Vietnam, green banking has been mentioned since 2011, according to Decision 1393/QD-TTg dated September 25, 2012 of the Prime Minister approving the national strategy on green growth for the period 2011-2020 and vision to 2050, "Green Finance" and "Green Banking" are considered parts of "Green Growth". Pursuant to Decision 403/QD-TTg dated March 20, 2014 of the Prime Minister approving the National Action Plan on Green Growth for the 2014-2020 period, on August 6, 2015, the Governor of the State Bank of Vietnam issued Decision No. 1552/QD-NHNN promulgating the Action Plan of the banking sector to implement the National Strategy on Green Growth to 2020. Regarding digital transformation, on June 3, 2020, the Prime Minister signed and issued Decision No. 749/QD-TTg approving the National Digital Transformation Program to 2025, with a vision to 2030. In the banking sector, digital transformation has been and is being strongly promoted. On December 26, 2019, the Governor of the State Bank of Vietnam signed Decision 2655/QD-NHNN approving the Strategy for IT development of the Vietnamese banking industry to 2025, with a vision to 2030.

2. Literature review

2.1. Green banking

The concept of green banking first appeared in 2003 in Europe with the aim of protecting the environment, and was later developed more strongly by countries, through research by scholars, theorists and economists. Lymperopoulos and colleagues (2012) believe that the category of "Green Banking" can be generally understood as a model of "Sustainable Banking", in which the bank "needs to develop sustainably, then investment decisions need to look at the big picture and act in a way that benefits consumers, the economy, society and the environment. According to Millat and colleagues (2013), green banking can be approached in two directions: Focusing on greening the bank's internal operations; Financing environmentally friendly projects, focusing on socio-environmental factors in the loan appraisal process. Foster and colleagues (2020) consider that a Green Bank is a bank that directly reduces environmental impacts such as energy, water, and waste treatment, or indirectly impacts the environment by increasing support for environmentally friendly projects such as: waste gas plants, renewable energy and solar power plants, or biofertilizer plants. Goddy and colleagues (2020) consider that the concept of a "Green Bank" is a bank that has many activities to encourage environmental activities and reduce carbon emissions such as encouraging customers to use green products and services, or applying environmental standards when approving loans or granting preferential credit for CO_2 reduction and renewable energy projects. Or, the category of "green bank" can be understood as a bank that provides services and products closely linked to environmental commitments or invests in green and clean production loans.

McEwen and colleagues (2020), Prestage and colleagues (2009) argue that green banking has the following basic characteristics: “Deploying electronic and automated services, prioritizing lending or investing in projects that assess environmental risks; paying attention to social goals, sustainable development goals and green development, having detailed supervision and guidance on customer projects to minimize the risk of environmental pollution, and changing the assessment capacity of bank staff and customers on environmentally friendly activities”. Ransom and colleagues (2005) and Tu & Dung (2017) argue that the products and services that a green bank needs to provide to customers include (i) Online banking services that help commercial banks “reduce the amount of paper, energy and other natural resources in use, through bills such as telephone, cable TV, services, credit cards can all be done remotely via Internet connection from a computer or smartphone”; (ii) Infrastructure such as ATMs or specialized screens located at the bank in an environmentally friendly way that the bank can provide, to encourage customers to use by offering attractive interest rates or exempting (reducing) usage fees; (iii) Green loans, including “household support loans, loans to build shopping centers, or car loans”; (iv) Green cards such as credit cards and debit cards so that banks can “contribute money to environmental protection organizations through each currency unit spent on the card” (usually 0.5% of the value of each purchase or transfer transaction). There are many ways to classify, but most agree to divide green banking activities into two main groups: green credit and internal green banking activities.

2.2. Digital transformation of the banking industry

According to Microsoft (2017), digital transformation is the restructuring of thinking in the coordination between data, processes and people to create new values. The Center for Research and Application of Information and Communications Technology (2022) defines digital transformation as the process of using digital technology to change or improve business operations, increase productivity and business efficiency. According to FPT (2023), a leading unit in providing digital transformation services and supporting banks in digital transformation, digital transformation in banking is a change in culture, organization and the way banks operate through technology. In the banking industry, digital transformation is the improvement of service-related areas including: Process automation, improving customer experience, data integration, improving organizational flexibility and sales. Sticking to banking operations, VIB (2023) believes that digital transformation in the banking industry is the process of converting traditional operations into online and automated operations using digital technologies; these technologies can include mobile applications, online payment systems, artificial intelligence and more; from issuing credit cards to transferring money and managing accounts, digital transformation in the banking industry helps banks create a safe and convenient online operating environment for customers; customers can perform their transactions anywhere.

3. Methods

The study uses methods of synthesis, analysis and use of analytical data from reports and data from the Ministry of Finance, the State Bank, Commercial Banks and international organizations (IMF, WB, ADB), using qualitative research methods to assess and analyze the current status of green banking development in the current Vietnamese commercial banking system. The article will address research questions on basic concepts of green banking and digital transformation of the banking industry, experiences in developing green banking in the world, assessing the current status of green banking development in the context of digital transformation in Vietnam, solutions for developing green banking in the context of digital transformation in Vietnam to promote the implementation of national digital transformation goals and sustainable development.

4. Results

4.1. Experiences in developing green banking in the world

4.1.1. Germany's experience in developing green bankin

The government builds a legal framework for effective and fair management of the green banking system; implements many financial support programs for commercial banks to implement green banking. The German Bank for Reconstruction and Development plays a key role in designing green financial products. The government provides this bank with rediscount loans to support the banking system. Before granting credit, banks evaluate the economic efficiency of projects, but when approving project credit, banks review whether the project complies with environmental, health and safety principles for the community or not, and to what extent. Outstanding credit focuses on environmental projects, energy saving, soil protection, and water pollution control.

4.1.2. China's experience in developing green banking

The People's Bank of China has issued policies and regulations on the use of credit to protect the environment. The China Banks Association has instructed banks to issue annual reports on corporate social responsibility. The green credit policy is implemented in conjunction with other national environmental programs jointly issued by three agencies: The Ministry of Natural Resources and Environment, the People's Bank of China, and the Financial Supervisory Commission, including: Green security policy, green insurance, green securities, etc. Commercial banks consider the environmental aspects of projects before disbursing and stop lending to projects that have serious impacts on the environment; implement a coordination mechanism between commercial banks and ministries and sectors in the issue of sharing information on the impact of production and business activities on the environment. According to statistics, loans for energy-saving environmental protection projects tend to increase. Many commercial banks have built a database on the environmental risks of customers.

4.1.3. Bangladesh's experience in developing green banking

Bangladesh is a country heavily affected by the world's environment. Environmental pollution problems in this country include: air pollution, water pollution, scarcity, encroachment of rivers, improper treatment of industrial and medical waste, deforestation and loss of biodiversity. According to WHO statistics in 2014, Bangladesh ranked fourth in the list of heavily polluted countries with an average PM2.5 index of 79 micrograms/m3. Faced with this situation, since 2011, Bangladesh Bank has shifted to developing green banking activities to protect the environment and improve financial sustainability. The Bangladesh Bank is the first central bank in the world to have a policy and implement the formation of a green bank (Lalon, 2015). The Central Bank has issued circulars guiding commercial banks to develop their own handbooks and policies applicable to each bank to implement green banking development strategies. Green Office Guidelines are communicated to all employees to effectively use electricity, water, paper, etc. Online communication methods are used instead of printing which wastes paper and ink in office management, printers are set to double-sided printing to save paper, Ecofont fonts are used to save ink, LED bulbs are used to save electricity. Online banking activities are strongly developed, reducing printing costs, postage, etc. (Islam and MT, 2015). Green banking activities in Bangladesh are like each member in the same house having mutual influence and support; specifically established, forming a pattern in operation; It is not only about building green credit policies in an environmentally friendly direction, but also about implementing a green revolution in banking operations, using new energy sources, digitalization and other measures to reduce carbon emissions of banks themselves (Vu Thi Kim Oanh, 2015).

4.2. Current status of green banking development in the context of digital transformation in Vietnam

4.2.1. Current status of green banking development in the context of digital transformation

In order to anticipate the development trend of science and technology, Deputy Governor of the State Bank of Vietnam Nguyen Kim Anh (2018) - Head of the Fintech Steering Committee of the State Bank of Vietnam said that Vietnamese commercial banks have proactively researched and invested heavily in a number of technological achievements of mankind in their products, services, operations and administration. Most notably, the practical implementation of digital platform technologies such as: Cloud computing, big data analysis, artificial intelligence, applications and solutions such as biometric authentication, ... to improve operational efficiency, enriching customer experiences.

According to a survey by the State Bank of Vietnam in 2023, 100% of banks have developed or are developing a digital transformation strategy or plan to develop and implement this plan. Of these, 49% of banks have approved a digital transformation strategy to develop business and information technology, and 51% are developing a digital transformation strategy. Most Vietnamese banks have implemented digital banking at the level of process and communication channel transformation, while data platform transformation has only been implemented at a few pioneering banks.

Currently, there are 3 main levels of digitalization for banks: digitalization of customer communication channels, digitalization of business operations, and pure digital banking. Up to now, it can be seen that Vietnamese banks have reached level 2 digital transformation. Banks have invested heavily in new technologies and core banking to serve digital transformation. Some pioneering banks have provided digital services to customers very early, such as: Vietcombank started with the Internet Banking version for individual customers and the VCB-Money system for institutional customers since 2001; VietinBank replaced the Core Banking system (Core SunShine) and deployed the EDW enterprise data warehouse since 2017; VPBank built the YOLO digital bank with its own Core banking system, separate from the current system in 2018; ... Some recent typical examples include: BIDV completed the construction of a modern infrastructure for Open API - BIDV Smart Connect with a speed of up to

5,000 transactions/second, connections and sharing are secured at many levels; Agribank launched the Digital Banking model - Agribank Digital. There are many modern, breakthrough technologies that have been applied by banks in their operations. Modern technologies include: (i) Electronic payment solutions with electronic payment gateways, cards or e-wallets are becoming increasingly familiar and gradually becoming popular; (ii) Blockchain technology, in which BIDV pioneered the application of Blockchain in trade finance, becoming the first Vietnamese bank to successfully apply Blockchain technology in the transaction of issuing letters of credit to a notifying bank outside the system; followed by MB, VPBank, Vietcombank, ... have applied Blockchain in a number of financial transactions. (iii) Application of artificial intelligence (AI), for example: BIDV Smart Banking applies AI to launch digital transaction space and put robots into use (2019); VIB combines AI technology with Big Data processing technology into the credit scoring process and credit card limit approval (2020); SHB launches robot - assistant SAHA directly serving customers at headquarters (2022); (iv) Biometric technology (voice, face, fingerprint, iris recognition) with TPBank with LiveBank application (2022), many other banks have also applied such as: BIDV, VietinBank, VIB... Vietcombank applies both biometric technology and new technology, Push Authentication, to launch digital bank VCB Digital from 2020; (v) Increasingly focusing on data-based decision making: VPBank applied IBM's data analytics technology to synchronize customer data, supporting customer behavior analysis since 2015, in 2021 launched digital bank Cake by VPBank, in 2022 had nearly 2 million customers; BIDV established Data Management Center in 2020; KienLongBank signed a strategic cooperation agreement with BPC Banking Technologies to provide SmartVista product suite to manage the entire ATM and POS system in 2022. Notably, in 2022, VIB deployed operations on Metaverse, through cooperation with virtual reality platform Bizverse World to establish VIB showroom, customers can visit VIB virtual showroom, register to open and receive credit cards immediately within 15-30 minutes with a limit of up to 200 million VND.

Digital banking has become an important part of the business strategy of many banks. Banking ecosystems are gradually taking shape. A standard banking ecosystem will include 3 service layers: Core banking service layer includes basic services such as: payment, credit, investment, trade finance, etc.; Banking ecosystem service layer includes services such as: spending management, education, discount, accounting, tax management, etc.; Non-banking service layer includes services such as: health care, housing, telecommunications, securities, etc. In Vietnam, the services in the banking ecosystem are focusing on core banking services and some banking ecosystem services. In particular, banks leading in digital transformation such as Vietcombank, BIDV, VietinBank, VPBank, Techcombank, TPBank, ..., can be said to have formed and gradually completed the banking ecosystem. For example, Vietcombank has succeeded in connecting directly with customers' ERP systems; connecting to provide level 4 public services with the National Public Service Portal, State Treasury, Social Insurance, hospitals, traffic, tax information portal for foreign suppliers, ...; continuously expanding cooperation and connection with payment intermediaries, Fintechs in the market; BIDV is also increasingly perfecting the digital ecosystem with BIDV Smart Banking, BIDV iBank, ... The remaining banks such as Agribank, Sacombank, HDBank, ... products and services in digital applications are still limited to the core banking service layer. Banks have made changes in their organizational models to serve the development of digital banking, including: (i) For banks with small shareholdings, they tend to choose the model of establishing new business segments or establishing pure digital banks, typically: VPBank established the Banking Digitalization Center (Digital Lab) along with developing the Timo model - a model without traditional bank branches (in 2017), LienVietPostBank piloted a smart digital transaction office with digitized procedures (October 2021); (ii) For large-scale banks, mainly state-owned commercial banks, are moving towards model number 1 - digital transformation on the basis of current business operations such as: BIDV, Vietcombank, ACB, ... have made great strides in organizational models by establishing a Digital Banking Center and a Data Management Center.

According to the State Bank of Vietnam, in 2023, non-cash payment transactions increased by 79.7% in quantity and 37.5% in value; transactions via the internet also increased by 58.39% and 42.76% respectively; via mobile phones increased by 100% and 96.68% respectively; via QR codes increased by 66.52% and 121.62% respectively over the same period in 2022. As of 2023, there were nearly 6.5 million active accounts opened online (eKYC); nearly 9.9 million cards opened with eKYC in circulation and about 133 million payment accounts; the number of transactions on the internet banking channel increased by nearly 58% compared to 2022 and the transaction value increased 13 times (from 11 million billion VND to 12 million billion VND); The number of transactions and transaction value on mobile banking channels also increased by 100%. The total number of activated e-wallets increased by 20.37% compared to 2022. The number and value of transactions via the bank's digital transaction channels have grown very positively. According to the State Bank of Vietnam, in 2022, transactions via the interbank electronic payment system increased by 18.24% in quantity and 53.21% in value compared to 2022. Many credit institutions assessed that there was a high level of readiness for the application of popular technologies. For customers, up to 95% of bank transactions have been carried out on digital channels. Transaction costs on digital channels have decreased significantly compared to traditional channels.... To date, 95% of bank records do not use documents in business processes. According to the State Bank of Vietnam's forecast, the value of mobile payments in Vietnam is expected to increase four times, from 16 billion USD in 2016 to 70.9 billion USD in 2025.

In recent years, under the direction of the Government through strategies, guidelines and guiding documents, many banks have been interested in green credit, typically VietinBank, Techcombank, Sacombank..., actively implementing green credit products such as energy saving loans, renewable energy loans, clean production loans... According to the State Bank of Vietnam (2023), 24/35 banks have developed strategies to manage environmental and social risks; 24/35 banks have integrated environmental and social risk management into the green credit assessment process; 15/35 banks have developed credit products and banking services for the green sector and are interested in granting credit, mainly in the medium and long term with preferential interest rates for green projects.

Fintech and Bigtech are facilitated to develop, are actively participating, both competing and cooperating with banks, contributing to accelerating digital transformation for the banking system. For Fintech, the State Bank has granted operating licenses to provide payment intermediary services to 48 non-bank organizations, including more than 40 units providing e-wallet services. According to statistics from the State Bank as well as the Vietnam Fintech Market Report 2023, the number of Fintech companies has increased 4 times, from 39 companies at the end of 2015 to nearly 200 companies in 2023. Among Fintech companies in Vietnam, about 80% are startups. According to the announcement of Temasek and Bain & Company on October 27, 2022, Vietnam achieved the highest digital economic growth in Southeast Asia: the total value of goods in 2022 is expected to increase by 28% thanks to the 26% growth of e-commerce compared to the same period last year; 60% of digital consumers; 55% of digital consumers are willing to pay 5% more for sustainable products or services; e-commerce attracted 280 million USD in investment capital in 2023, becoming the most favorite investment sector; 95% of digital consumers plan to maintain or even increase their use of e-commerce platforms in the next 12 months. According to Robocash Group's assessment (2023), Vietnam's Fintech market is the second fastest growing in the region, after Singapore, expected to reach 18 billion USD by 2024 with a high level of competition. Vietnam is also ranked No. 1 in the world in terms of global cryptocurrency adoption index in 2023. Regarding Bigtech, currently, large technology companies in Vietnam (FPT, Viettel, CMC, VNG, VC Corp...) or Vingroup, Grab... with a huge number of users have been accessing financial services through the development of electronic payment technology.

The Open Banking trend helps customers use banking products from many different applications in addition to digital banking applications, while helping banks reach a diverse range of customers at reasonable costs through other applications of partners. OCB is a pioneer in implementing the open banking model with an open application programming interface (API) platform in 2019 with 30 APIs so that partners can connect the OCB system to the ecosystem. VietinBank also launched iConnect - an Open Banking platform in 2019, providing more than 100 APIs and has connected with over 60 partners via APIs at the time of launch, this number has now doubled. Other banks such as BIDV, Vietcombank... have initially built and deployed Open API to partners. Nam A Bank brings to users and customers Open Banking version 2.0 with a modern and different interface. In general, banks are increasingly expanding cooperation and connection with technology companies and Fintech to anticipate and take advantage of business opportunities from digital platforms.

In addition, the trend of banks cooperating with Regtech, Suptech, Proptech has begun to be implemented in Vietnam in different forms, in which Regtech is an information technology application to support legal enforcement for financial institutions (Regtech for Financial Institutions); Suptech is an information technology application to support legal enforcement for management and supervision agencies (Regtech for Supervisors); Proptech is the application of information technology and platform economics to the real estate market, abbreviated as real estate technology.

Some typical services of commercial banks can be mentioned as: Digital Lab digital banking space developed by Vietcombank; LiveBank automatic bank of TPBank; Timo digital banking application of VPBank; Vietinbank has developed a new generation core bank and a modern enterprise data warehouse; MBBank applies ChatBot virtual assistant to serve 24/7 on social networks.

4.2.2. Some typical models of green banking development in the context of digital transformation in Vietnam

A typical commercial bank in the green banking movement is Vietinbank. VietinBank issued an action plan with specific contents: (i) Building a development orientation for "Green Banking" through the decision to establish the Project Implementation Board; perfecting appropriate policy mechanisms to aim for the following goals: Reviewing/updating the contents of policies on environmental and social management in credit granting activities to suit the new model of VietinBank; building annual credit orientations, including environmental management contents; building guidelines for environmental and social appraisal in credit granting activities; (ii) Strengthening the capacity of officers, specialists and employees implementing "Green Banking - Credit" through organizing training, propaganda and dissemination to raise awareness of "Green Banking - Credit" activities, raising awareness of efficient use, saving energy, natural resources and environmental protection; (iii) Develop solutions to promote “Green Banking - Credit” products, support businesses in implementing green growth; focus bank credit capital on projects and business plans to minimize and adapt to climate change, develop modern banking services, use high technology, and are environmentally friendly.

On the banking side, VietinBank provides credit to businesses to invest in machinery and equipment, supplement working capital to serve the production and business activities of environmentally friendly products and equipment, protect the health of consumers and do not pollute the environment. Programs oriented by the Government and the State Bank of Vietnam are also quickly implemented by Vietinbank such as: Rural Agriculture Loans according to Decree 55, High-tech Clean Agriculture Loans, Supporting Industry Loans, ... Corporate customers operating in the green sector are proactively applied preferential policies by VietinBank through appropriate credit products/programs; accompanying corporate customers, the VietinBank SME Stronger incentive package offers preferential interest rates and fees, optimizes capital use efficiency, improves operational efficiency, and expands production and business.

Throughout 67 years of construction and development, BIDV has always been a pioneer and exemplary unit in implementing corporate social responsibility, associated with activities that bring great benefits to the community, joining hands with society to protect a green - clean - beautiful living environment. To effectively implement the State Bank's guidance on developing a Green Bank, BIDV has researched and approached international practices and recommendations such as the Safeguard Policy Statement and Gender and Development Policy of ADB as well as the requirements on environmental and social protection of the IFC (WB) to issue BIDV's own Environmental and Social Risk Management Framework (S&E). BIDV promotes the development of a common framework for developing a Green Bank, specifying regulations on environmental risk assessment when appraising and approving credit granting. BIDV is the first bank to issue regulations on the Environmental and Social Risk Management Framework applicable to Projects funded by ADB loans, encouraging other projects to apply and implement.

4.2.3. Comparison of digital transformation status of green banking system in Vietnam

VIB (2023) compared the digital transformation status between Vietnamese banks and international banks as follows:

Table 1: Comparison of digital transformation situation between Vietnamese banks and international banks

Index	Digital transformation in Vietnamese banks	Number of banks that have implemented digital transformation
	Most banks have been implementing digital transformation for many years, with high international standards of information security and service availability.	Up to now, many banks in Vietnam have implemented digital transformation and developed digital financial services
Diversity and Convenience of Digital Services	International banks provide a wide range of convenient digital services, including money transfers, bill payments, online investments, online lending and more.	Banks in Vietnam also provide digital financial services, increasingly improving the diversity and convenience of these services
Development of Digital Infrastructure	International banks have invested heavily in digital infrastructure, including servers, databases and networks to ensure the security and availability of services	Banks in Vietnam are also investing in digital infrastructure, despite facing challenges in scale and scope, but have achieved many significant achievements so far
Innovation and Creativity	International banks are always looking for new and innovative approaches in developing digital financial services to meet customer needs	Digital transformation in Vietnamese banks also brings similar benefits to users, constantly researching and innovating to ensure convenience for customers.
Speed of Transformation	Fast	There is significant progress

Source: VIB (2023)

4.2.4. Advantages and difficulties of digital transformation of green banking system in Vietnam

Advantages: Based on Decision No. 1604/QD-NHNN dated August 7, 2018 of the State Bank of Vietnam on approving the project to develop green banking in Vietnam, it can be seen that the development of green banking in Vietnam is currently receiving great attention from the State Bank. Tu and Hao (2021) said that some positive growth in green banking in the Vietnamese market can be seen such as (i) "Internet payment transactions increased by 49.3% in quantity and 31.34% in value"; (ii) "payment transactions via mobile phone channels increased by 74.64% and 86.58% respectively; (iii) "QR Code payment transactions increased by 50.36% in quantity and nearly 131%" in value. Regarding green credit in particular, statistics from the State Bank of Vietnam show a number of achievements such as (i) Total outstanding credit balance in 2019 for green projects reached VND 317.6 trillion, up 29% compared to 2018 and accounting for 4.1% of total outstanding credit balance, twice as high as in 2015; (ii) Considering "the structure of outstanding loans by term, medium and long-term outstanding credit balance accounts for 76% of outstanding green credit balance, of which, short-term lending interest rates for green sectors range from 5-8%/year, medium and long-term" from 9-12%/year; (iii) Considering "the structure by sector, outstanding green credit balance mainly focuses on green agriculture, accounting for 45% of total outstanding green credit balance; renewable energy, clean energy accounts for 17%; Sustainable water management in urban and rural areas accounts for 11% and sustainable forestry accounts for 5%.

Difficulties: According to statistics in 2024, from reports of 26/31 domestic banks, the total number of branches and transaction offices of commercial banks has reached more than 11,300 transaction points nationwide. With such a large number of transaction points of banks, the implementation of transaction activities of commercial banks today can still cause negative impacts on the environment, especially carbon emissions. The reason is that commercial banks today still continuously use large quantities of printed documents, printing equipment, photocopying, air conditioners and lighting equipment, thereby causing many negative impacts and adverse effects on air sources and the surrounding natural environment. Therefore, to improve the effectiveness of green banking in the Vietnamese market is an extremely difficult challenge, when the number of transaction points is always increasing more and more.

According to the survey results of the State Bank on the topic of "green growth - green credit", the current level of understanding of banks and credit institutions is still relatively low, leading to the awareness of customers and Vietnamese students about this green banking field is still very poor, for example: (i) Only "19 banks and credit institutions have developed environmental and social risk management strategies"; (ii) Of which, "only 13 banks and credit institutions have integrated environmental and social risk management content into the green credit appraisal process"; (iii) Even in 2022, only about 15 credit institutions have developed credit products and banking services for green fields, accounting for 10% of the total number of credit institutions in Vietnam.

The development of green credit by banks in our country contributes positively to the balanced and harmonious development between economy, environment and society; contributes to hunger eradication and poverty reduction; avoids ecological risks that many countries have encountered due to over-focusing on economic growth. For businesses, green credit development is an opportunity for businesses to access preferential loans from domestic and foreign sources as well as receive long-term support from the State; avoids environmental risks and contributes to the sustainable development of businesses. However, currently, Vietnamese banks are still in the process of learning and accessing new technologies and credits for new energy. Therefore, there are still some limitations in assessing the risks of these projects, leading to capital support efficiency not being as high as that of conventional projects. Previously, Vietnamese banks tended to focus on collateral rather than on project investment cash flow. However, in recent years, banks have tended to shift to green credit products, including long-term energy saving projects.

Implementing the Government's direction, the State Bank of Vietnam issued Directive No. 03/CT-NHNN dated March 24, 2015 on promoting green credit growth and managing environmental and social risks in credit granting activities. According to the State Bank's direction, from 2015 onwards, credit granting activities need to focus on environmental protection, improving the efficiency of resource and energy use, improving environmental quality and protecting human health, ensuring sustainable development. Most recently, Decision No. 1604/QD-NHNN dated August 7, 2018 of the State Bank of Vietnam approved the Green Banking Development Project in Vietnam with the aim of raising awareness and social responsibility of the banking system towards environmental protection, combating climate change, gradually greening banking activities, directing credit flows into financing environmentally friendly projects, promoting green production, services and consumption, clean energy and renewable energy; actively contributing to promoting green growth and sustainable development. The goal by 2025 is that 100% of banks will develop internal regulations on environmental and social risk management in credit granting activities, 100% of banks will conduct environmental and social risk assessment in credit granting activities, apply environmental standards to projects funded by banks, combine environmental risk assessment as part of the bank's credit risk assessment, at least 10-12 banks will have a specialized unit/department on environmental and social risk management, 60% of banks will have access to green capital and deploy lending for green credit projects. The Development Strategy of Vietnam's Banking Industry to 2025, with a vision to 2030, issued together with Decision No. 34/QD-NHNN dated January 7, 2019, set the goal of promoting the development of non-cash payments, optimizing the ATM and POS network, and in 2020, the proportion of cash in total means of payment will be below 10%, and in 2025, this figure will decrease to 8%.

According to the survey results of the State Bank, there are still some green banking products and services that have not yet deployed online transactions, especially products and services related to green financial investment (Dieu, 2021), specifically: (i) "95% of banks have built or are planning to build a digital transformation strategy, of which only 39% of banks have approved a digital transformation strategy, or integrated it into their information technology business development strategy"; (ii) "Only 42% of banks are building a digital transformation strategy and of which the majority (88%) of banks have chosen to digitally transform customer communication channels (front-end) and internal operations (back-end) or digitize the entire channel, of which the remaining few banks (6%) plan to digitize customer communication channels" (front-end only); (iii) Regarding “the benefits of digital transformation in the next 3 to 5 years, 82.5% of banks expect revenue growth of at least 10%, 58.1% of banks expect more than 60% of customers to use digital channels and 44.4% of banks expect customer growth rate to reach more than 50%, a figure that is considered relatively low compared to the State Bank's growth target for green banking development".

5. Solutions for developing green banking in Vietnam in the context of digital transformation

5.1. Building a long-term development strategy

To widely and effectively develop the green banking model in Vietnam, along with the green growth of the whole economy, there needs to be close coordination between the Government, the State Bank, banks and related organizations. Accordingly, specific action programs need to be implemented with a clear roadmap, goals and expected results. To do so, there needs to be direction and support from the Government and the State Bank in terms of guidelines, policies, mechanisms, capital, etc., as well as the efforts of each bank itself. The State Bank needs to continue to improve the legal system, policies, mechanisms, technical infrastructure, creating favorable conditions for banks to deploy products. State management agencies in general and the State Bank in particular, in the process of building and proposing solutions to perfect the Fintech ecosystem in Vietnam, need to facilitate the development of Fintech enterprises in Vietnam, in line with the Government's policies and orientations on a digital economy in the future.

5.2. Perfecting the legal system

To meet the wave of modernization in the digital transformation, the State Bank needs to continue to review, revise and perfect the legal corridor to facilitate and support the development and operation of digital banks; support and promote new products and services; create a legal environment to promote innovation of Fintech organizations, encourage safe and effective Fintech solutions. The banking industry actively implements Directive No. 16/CT-TTg dated July 5, 2017 of the Prime Minister on enhancing the capacity to access the 4.0 Industrial Revolution, focusing on perfecting the legal corridor to support payment activities, payment systems, ensuring safety and security in banking activities; increase investment in upgrading IT infrastructure, national interbank payment systems. In particular, a very important issue that the banking industry focuses on is training human resources to be able to adapt to the very high requirements of digital transformation.

5.3. Linking green banking with banking culture

The application of the green banking model will contribute to creating a culture in the use of banking services by customers. When the use of banking services becomes more convenient, more preferential and less expensive (through online banking, green accounts and green credit cards...), consumers will tend to use banking services more and more. This will raise social awareness in the use of banking services, contributing to creating a future society where financial and banking services become an indispensable part of daily life.

5.4. Development of online banking and green payment accounts

Developing online services such as online bill payment, online transfer, online account management, online shopping, etc. is one of the ways that banks can use to reduce the use of paperwork, reduce travel time, save costs and natural resources consumed through banking activities, contributing to preserving the green environment. Banks can save costs by reducing paperwork, reducing offices and branches, building more energy-efficient buildings, reducing complicated procedures and focusing human resources on more important operations. Opening a green payment account can contribute to protecting the environment by using more online banking services. For example, mobile banking, bill payment, credit cards, account statements, free ATM use, security.

5.5. Investment in technology infrastructure

Commercial banks need to be more proactive in modernizing their information technology systems, upgrading new generation core banking systems, investing in the fundamental technologies of the 4.0 industrial revolution to meet the development trend of digital banking, banking - Fintech cooperation...;

constantly researching and applying new breakthrough solutions and technologies such as: innovative and creative payment solutions (mobile payment via standardized QR code, digitizing card information - Token, chip card payment technology...), open data connection and sharing platforms via application programming interfaces (open API), big data analysis (Big Data Analytics), artificial intelligence (A.I)... to provide convenient banking products and services, reasonable prices in the direction of digitalization, intelligence, bringing practical benefits to customers in the digital age.

One of the factors that has the greatest impact on the level of understanding of Vietnamese customers towards green banking is awareness of energy saving. Therefore, the study recommends that commercial banks can raise awareness of Vietnamese customers about green banking by raising their awareness of energy saving. To do that, commercial banks should make efforts to encourage customers to actively switch to using commercial bank products and services that emphasize energy saving, instead of traditional products and services that cause significant energy loss.

More specifically, the recommended products and services are technological and electronic applications with new, advanced advantages of commercial banks, in order to save energy compared to before. In addition, bank managers must pay more attention to energy saving in the business and product development process, in order to provide and bring products that promote environmental friendliness to consumers, thereby raising customers' awareness of using green products. To do that, bank managers build long-term business strategies related to recycling and energy saving.

Awareness of green investment is still new to Vietnamese customers in general, so banks can raise their awareness of green banking by actively introducing and encouraging customers to use green utilities, typically green loans, green mortgages, or green investments provided by commercial banks. Not only stopping at introducing, commercial banks actively cultivate and update new debit and credit card products from advanced technology in the world, made from environmentally friendly recycled materials, helping customers have the opportunity to approach closer and more familiar with products and services in the green banking model.

6. Conclusion

Through the analysis of the above article, it can be seen that most commercial banks in Vietnam have been implementing sustainable development goals, implementing the policy of developing green banking and digital transformation strategy in banking, however, there are still many barriers in the implementation process. Among them, there are barriers that need to be resolved quickly to successfully implement the strategy of safe, effective and sustainable development of the commercial banking system such as: perfecting the legal framework on sustainable development, improving the quality of human resources and increasing capital capacity, perfecting the environmental and social risk management system, investing in high-tech infrastructure. Based on the analysis of the current status of influencing factors as well as assessing the impact of those factors on the sustainable development process of Vietnamese commercial banks, the topic has proposed solutions for the sustainable development of Vietnamese commercial banks in line with the trend of international integration.

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The Impact of 4.0 Technology on the Clean Vegetable Supply Chain in the Circular Economy Model in Vietnam

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Abstract

In the context of a constantly fluctuating world economy, the process of industrialization and modernization of the agricultural sector is taking place stronger than ever. The study used data from businesses in the period 2018 - 2024 to determine the impact of applying 4.0 technology on the efficiency of the clean vegetable supply chain at these businesses. Research results show that businesses' use of technologies such as the Internet of Things, Blockchain, and bio-anaerobic technology have a positive impact on production efficiency, reduce waste, and optimize management processes. At the same time, Technology 4.0 helps promote the circular economy model in businesses, reduce negative impacts on the environment, create new values from surplus materials into organic fertilizer, ensure vegetable products are Absolutely clean, and inspire environmental protection and sustainable reuse.

Keywords: *4.0 Technology, clean vegetables supply chain, circular economy*

1. Introduction

In the context of international economic integration and the 4.0 industrial revolution taking place extremely strongly, the application of modern technology in agricultural production has become a key factor to improve quality and efficiency. manufacture. In particular, Vietnam's agricultural sector is receiving more attention than ever in the era of industrialization and modernization because of improved living standards and people increasingly concerned about the quality of food for daily consumption. A safe vegetable supply chain not only requires strict supervision of food safety but also must meet increasing consumer demands for product quality and origin. Technology 4.0 with advanced applications such as Internet of Things (IoT), artificial intelligence (AI), and Big Data are bringing breakthrough solutions, helping to improve production efficiency, reduce risks and reduce risks. Enhance transparency throughout the supply chain. In that context, implementing Technology 4.0 into the safe vegetable supply chain is not only an inevitable trend but also an urgent need to ensure the sustainable and competitive development of Vietnam's agricultural industry. .

2. Literature review

Technology is a term originating from the Fourth Industrial Revolution, marking the birth of a series of new technologies, combining all knowledge in the fields of physical, digital, and biological learning and influencing the economy and industries. In other words, technology is the creation, modification, use, and knowledge of tools, machines, techniques, crafts, systems, methods of organization, solving a problem, improving the way pre-existing way of solving a problem, achieving a goal, or performing a specific function. The 4.0 industrial revolution, with great inventions, created outstanding leaps in all fields. The Internet of Things (IoT) creates products related to all daily activities with the ability to exchange information. information via the Internet; Artificial intelligence (AI) creates devices and machines with human-like intelligence, capable of self-learning to improve accuracy in processing, prediction, decision support, etc.; Blockchain provides an efficient and secure method of storing and sharing data; Big Data allows the collection, storage, and analysis of large volumes of data to evaluate trends and establish appropriate operational strategies; 3D printing technology allows creating 3D products faster and easier than traditional techniques, with less tool consumption. This new production revolution has a strong impact on every country, government, business and people globally, as well as fundamentally changing the way we live, work and produce. The nature of Industrial Revolution 4.0 is to be based on digital technology and integrate all smart technologies to optimize production processes and methods. This new era of investment, productivity and rising living standards, all thanks to human innovation, will have a profound impact on the political, social and economic systems of the world.

Supply chain is a system linking business units from production, processing, packaging, distribution to consumption. The supply chain includes all activities and processes involved in the production and distribution of products from raw materials to the final customer. Supply chain networks of companies and organizations link together to produce and provide goods and services to customers, which has a huge influence on the development and competitiveness of businesses. .

Circular economy appeared in the mid-18th century in the agricultural sector, but it was not until the 20th century that it became an economic category that refers to a new economy model (Documents of the 13th National Congress, 2021). The circular economy concept was first used by Pearce and Turner in 1990, and is an economic model based on the basic principle that "everything is an input to something else". According to Clause 1, Article 142 of the Law on Environmental Protection 2020, the circular economy is an economic model in which design, production, consumption, and service activities aim to reduce the exploitation of raw materials, Extend the product life cycle, limit waste generated and minimize negative impacts on the environment. To date, the definition widely accepted by many countries and international organizations is that the circular economy is a restorative and regenerative system through proactive planning and design. It replaces the concept of end-of-life materials with the concept of recovery, shifting towards the use of renewable energy, away from toxic chemicals that compromise reuse, and towards waste reduction. waste through the design of materials, products, technical systems, and even business models within those systems" (Ellen MacArthur Foundation, 2012).

The Ellen Macarthur Foundation has identified three key principles of a circular economy:

(1) Reduction and elimination of waste and pollution;

(2) Extend the shelf life of products and materials;

(3) Regenerate natural systems.

These principles help circular economy break the usual link between economic development and negative impacts on the environment. Not only about circulating materials but also about minimizing the use of materials that are difficult to recycle, circular economy is not about waste treatment, on the contrary, it considers waste as a resource that is misplaced, or misappropriated. Price is not correct value. Accordingly, not only does it reduce dependence on resources and limit emissions, circular economic models still bring great benefits and promote economic growth.

3. Methodology

3.1. Research model

There have been many previous empirical studies showing that 4.0 technology is extremely important for the supply chain, especially for the circular economy. The advent of Fourth Industrial Revolution technologies helps link smart operations with supply chain design and processes to alleviate some of the shortfalls in operations. Supply chain operations, effectively integrating 4.0 Technologies into supply chain operations will significantly improve productivity, product distribution, cost optimization, asset management, reliability, and processes. efficiency, better sales, and overall performance of the production system. Some studies indicated that whether a business aims for a horizontal or vertical integration strategy, there must be a good connection between the links in the supply chain so that production can be smooth. Therefore, there needs to be a connection between members of the chain so that the flow of information, materials, and products flows accurately and promptly. Besides, greater transparency and awareness within the supply chain network will significantly improve performance. In addition, the supply chain also plays a role in managing risk and maximizing profits if businesses make smart decisions about how to operate production, imports, exports, and distribution. Building and managing an effective supply chain will help businesses optimize production, increase competitiveness, and achieve profit goals.

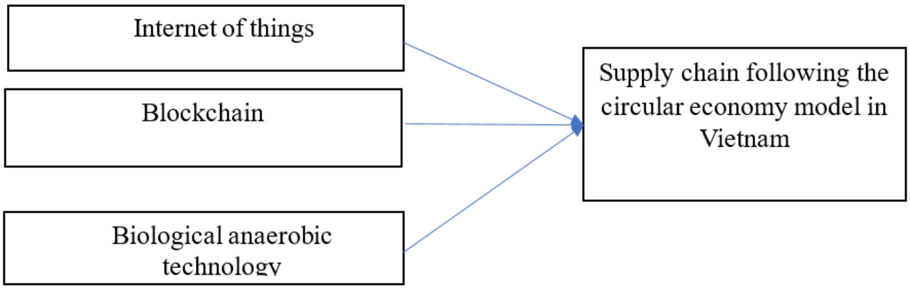

Figure 1: Research model

Source: Author

3.2. Research methods

Collecting and synthesizing data: The research was conducted by collecting and synthesizing secondary data through inheriting research documents related to the research problem. At the same time, the author took specific revenue data over the years at Minh Tan Safe Vegetable Cooperative.

Professional interview: The authors of the article used in-depth interviews with a number of business research experts and agricultural enterprises about the impacts of Technology 4.0 on the clean vegetable supply chain in Vietnam. From there, we propose some useful solutions to develop Technology 4.0 towards sustainable circular development.

4. Results

Technology 4.0 has played a major role in the clean vegetable production supply chain at a number of businesses in Vietnam. The Internet of things and Blockchain have helped businesses completely technologize and modernize production models and make reasonable calculations to make the most of resources, reduce human resources and capital while still achieving high productivity; Organic composting technology helps reproduce and use excess materials into effective, safe, secure input materials and contributes to environmental protection. All information about the clean vegetable production process is included in the QR code, so that the product is always monitored and trusted by consumers, increasing the reputation of the business and also allowing the business to easily manage every step. production in the clean vegetable supply chain through information technology advances; From there, strictly control vegetable quality and labor quality at the enterprise.

Table 1: Production situation of clean vegetables in Minh Tan safe vegetable Cooperative

Targets	2018	2019	2020	2021	2022	2023	2024*
Area (ha)	50	58	66	71	78	90	97
Productivity (ton/ha)	28.63	28,63	28,68	28,63	25,53	29,1	31,04
Output (tons)	1225	1661	1893	2033	2226	2439	2616
Total value - Revenue (million dong)	18240	23570	25190	27460	29300	33800	36150
Average output value (million VND/ha)	264,8	406,38	381,67	386,76	386,76	464,44	469,59

(*) As of June 2024

Source: Cooperative internal documents

Production and sales of clean vegetables at the enterprise when applying Technology 4.0 achieves remarkable efficiency. The supply of clean vegetables no longer faces very serious difficulties in agricultural production such as weather and land. Therefore, there are no more crop failures due to erratic rains, storms, floods, and droughts for the enterprise's agricultural production. With a smart system operated by machines in the greenhouse and remotely managed by smart devices, the environment for the growth and development of clean vegetables always reaches the optimal level in terms of all conditions such as temperature, light, humidity, irrigation water, nutrients. Soil quality is always carefully calculated with necessary nutrients and no chemicals when businesses use organic fertilizers produced by the company's own technology from the leftovers of the previous production process.

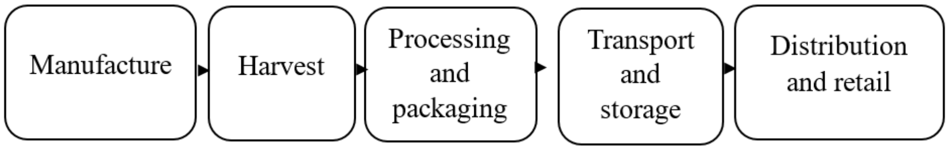

Figure 2: Brief diagram of the clean vegetable supply chain at some businesses in Vietnam

Source: Author

Based on the data table above, we see that the Cooperative always focuses on investing in physical and technical facilities, input factors and paying increasingly higher wages to workers. Profits are always positive, people are profitable in the production and business of clean vegetables, profits per hectare range from 100 - 250 million VND. This is a great motivation for producers and traders of clean vegetables in particular and cooperatives in general to continue to strive and bring clean vegetable products in large quantities to the market, reaching consumers in Vietnam. commune area as well as the entire city of Hanoi, moving towards foreign markets.

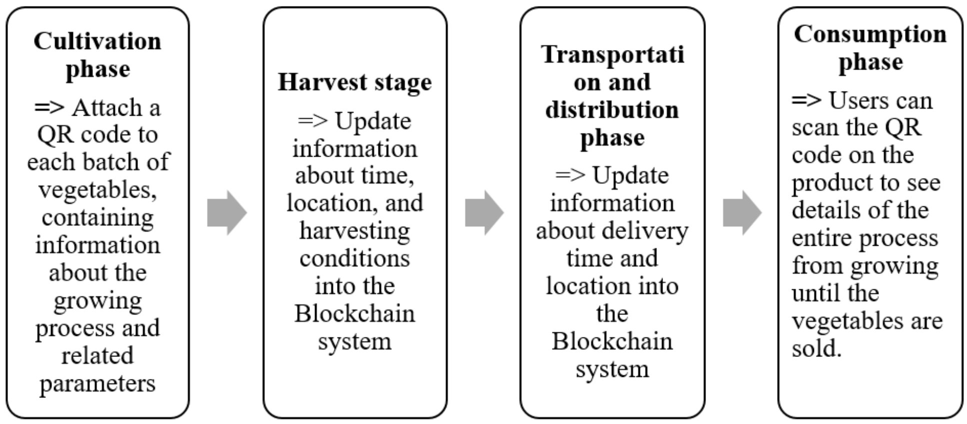

Figure 3: Overview of Blockchain technology at Minh Tan safe vegetable Cooperative

Source: Author

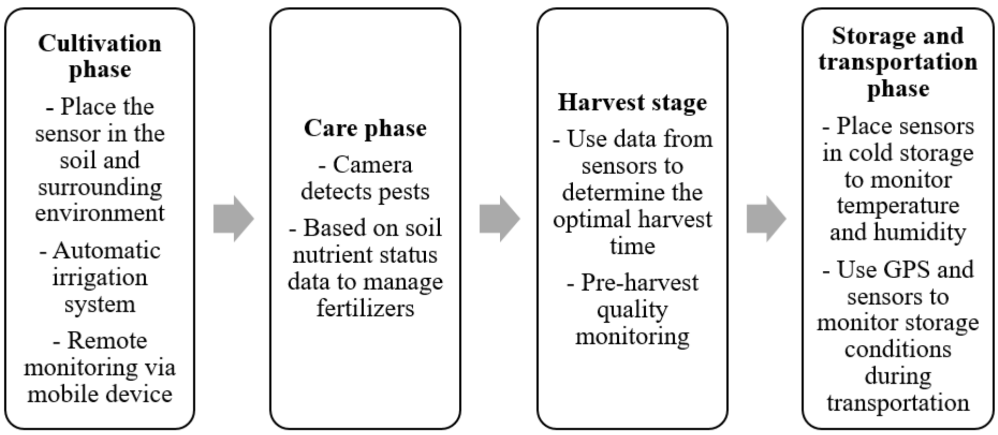

Figure 4: Overview of Internet of things application at Minh Tan safe vegetable Cooperative in the clean vegetable supply chain

Source: Author

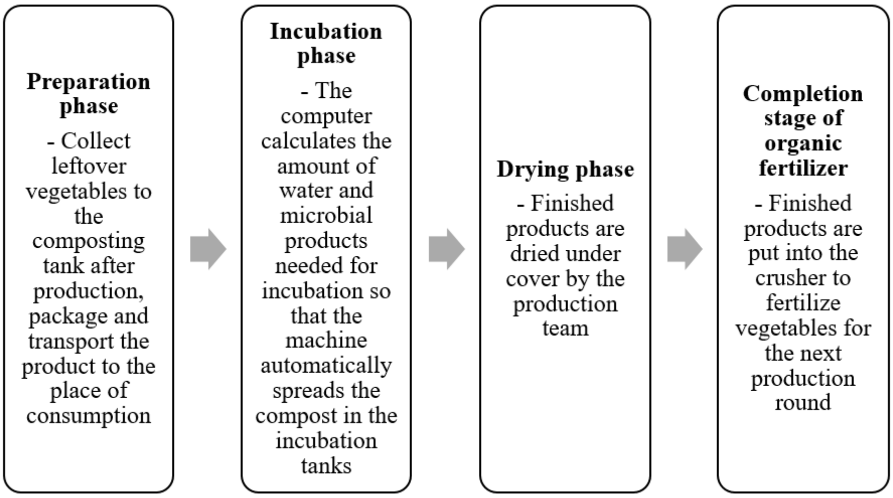

Figure 5: Overview of automatic anaerobic microbial technology at Minh Tan safe vegetable Cooperative in the clean vegetable supply chain

Source: Author

4. Conclusion and Implications for Vietnam

Research results have shown that all three technology systems: Internet of things, Blockchain and Anaerobic Biotechnology that turns waste into organic fertilizer to help reuse materials for the next production process all have an impact. Positively increase revenue and maximize production processes at businesses that have applied 4.0 technology to the clean vegetable production supply chain in Vietnam.

Based on the above analysis and estimation results, the author offers some solutions for Vietnam as follows:

Invest in upgrading the system to process excess materials into input materials: It is necessary to synchronously deploy and upgrade the composting tank system using bio-anaerobic technology to convert a larger amount of leftover raw materials after packaging vegetables into recyclable organic fertilizer for processing. next production. In addition to the enterprise's own excess raw materials, it is necessary to collect excess raw materials from outside or from other households. It is necessary to continue researching other forms of raw material reproduction to provide more raw materials. clean input materials for Vegetables, as well as diversifying ways to process and recycle raw materials for businesses.

Research into bringing renewable energy such as solar energy into the supply chain to provide electricity for equipment and management systems: After assessing the local solar energy potential, including the amount of annual sunlight and available area for solar battery installation, proceed to select the type of solar battery and equipment. Auxiliary equipment such as converters and energy storage systems (battery) are suitable for electricity use needs. Solar panels currently being distributed are mono, poly and thin-film... businesses can choose to install on the roof or available area to maximize energy absorption.

Improve the quality of the workforce, train skills and knowledge in using technology. It is necessary to continue investing in professional education to create high-quality human resources. Departments within the enterprise need to foster skills and knowledge, and moreover, must understand the technology the enterprise is using to successfully complete their tasks. Enterprises should identify the necessary skills and knowledge for the workforce, including soft skills and transferable skills along with flexible training methods such as face-to-face, online, combined, etc. Find experts Participation or reputable training organizations are a good option. After training, employees must go through evaluation methods and apply skills to work.

Actively use the system of online trading floors to access and sell clean vegetable products: Accessing more modern, trendier markets is inevitable, helping businesses expand their markets and reach a large number of consumers nationwide without being limited by geographical barriers. Typical examples include Shoppe Food, Lazada, Sendo,.... Traditional supermarkets also have "online shopping" services to increase convenience for consumers.

Enhance order management and payment through online payment system; and integrate order management system to track and process goods quickl:. Businesses need to choose reputable systems such as Momo, ZaloPay, ViettelPay... and strictly manage their accounts to avoid fraud. Besides, online payment methods can be linked to business websites or sales applications for customers to easily pay. Connect your order management system to your online marketplace and other sales channels to synchronize order and inventory data.

Enhance marketing and promotion of clean vegetables according to the circular economy model online: Build attractive advertising content, use high-quality images and videos to attract users' attention, and ensure advertising messages are clear, concise and convey the value of Vegetable products clean and circular economic model. Or create videos that convey messages, short stories, integrating product advertising in each video to raise awareness of environmental protection, while strengthening the corporate brand. Use a strong CTA (Call - to - action) to encourage users to take action such as making a purchase, signing up for information, or participating in a promotion. Then use analytics tools to track the effectiveness of your advertising campaign and continuously optimize for the best results.

Economic growth is associated with sustainable development: It is necessary to mobilize all resources for sustainable economic development, promote growth in all fields, promote new driving forces such as green, circular economy, develop strategic synchronous infrastructure, prepare high-quality human resources, application of science and technology, and innovation for the agricultural industry. Economic growth must go hand in hand with environmental protection, not only relying on profit goals to promote growth, improve labor productivity, promote restructuring of state-owned enterprises, and develop the private economy, selectively attract foreign direct investment, soon overcome resource allocation, take advantage of the opportunities of the 4.0 revolution based on three pillars of economy, environment and society.

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Orange Farming linked with Digital Transformation in Bac Quang district, Ha Giang province

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Abstract

This study aims to assess the current status and propose solutions to promote the application of digital transformation in orange cultivation in Bac Quang district, Ha Giang province, Vietnam. The methods include in-depth interviews, synthesis, data processing, comparison, and analysis. Orange trees play an important role in the economic development of Bac Quang district, covering a total area of 3,097.98 hectares. Digital transformation is recognized as an effective tool to enhance farmers' incomes, improve green growth, and access to scientific and technological advancements in production. The development of e-commerce platforms has disrupted the traditional technique of conducting transactions. Nevertheless, several obstacles hinder its widespread adoption. These include the small-scale implementation of digital transformation, inadequate infrastructure, limited financial capacity and awareness among some individuals, which restrict businesses and cooperatives from adopting advanced technologies in production, and a scarcity of highly skilled human resources in the agricultural sector. Additionally, there are few models of digital transformation in orange cultivation. The key solutions are proposed: completing modern, synchronized digital infrastructure; raising awareness among farmers, enterprises, and cooperatives regarding digital transformation; investing in cutting-edge technologies for processing and preservation; and strengthening the research, application, and transfer of science and technology.

Keywords: *Digital transformation, orange cultivation, E-commerce*

1. Introduction

The digital transformation of agriculture refers to the combination of digital technologies, such as IoT technology, with agriculture to simulate, monitor, judge, predict, and impact the entire process of agricultural production from crop planning, input, and output to harvesting, processing, and marketing agricultural products to improve resource utilization and product quality, reduce costs, and improve the ecological environment (Hackfort 2021; Mondejar et al. 2021). In recent years, numerous organizations and corporations have identified digital transformation as a critical component of their strategic objectives, particularly for evaluating, managing, and safeguarding information (Mendhurwar and Mishra, 2021). In the context of globalization, digital transformation represents an inevitable and rapidly expanding trend, affecting various aspects of social life (Verhoef et al., 2021; Vial, 2019; Huyen et al., 2023). Within the agricultural sector, digital transformation enables the automated implementation of spatially variable input applications and the collection of large amounts of geo-referenced data on field conditions. This advancement can enhance farm profitability, minimize input waste and environmental contamination, prevent over-application of inputs, and increase production efficiency (Khanna, 2021). According to Huyen et al. (2023), digital transformation is an important tool to help farmers and businesses produce high-quality agricultural products at the lowest feasible cost while generating the greatest profit. Shen et al., (2022) have emphasized that information technology and digitalization reform significantly impact agriculture, rural areas, and farmers, improving high-quality development and green growth in agriculture (Shen et al., 2022)**.**

The Bac Quang district, located 60 kilometers far from Ha Giang city at the southern gateway of the province, encompasses a total natural area of over 110,564.5 hectares. The region is traversed by two major rivers, the Lo and Con rivers, and is characterized by limestone hills interspersed with plains. The district comprises 23 administrative units, including 2 towns and 21 communes (People's Committee of Ha Giang Province, 2023). The provincial development plan for Ha Giang for the period 2021-2030, with a vision toward 2050, outlines several key innovations and strategic tasks, such as prioritizing the development of six major sectors (tourism, border economic development, industry-construction, agriculture, forestry, fisheries, education, and training) and focusing on four growth pillars (transport infrastructure, digital infrastructure, ecotourism, establishing a chain of specialty agricultural products, and modern urban areas). Specifically, Bac Quang district aims to become a significant economic hub for the southern region of Ha Giang, leveraging its strategic position as a transportation gateway to attract investment and develop into a processing and logistics center for highland agricultural and forestry products. The district is also set to evolve following a green urban model, with a focus on services, urban development, and industrial zones (Prime Minister of Vietnam, 2023). With a total of 3,079.98 hectares, Bac Quang district has the largest area dedicated to orange cultivation in Ha Giang province (People's Committee of Bac Quang, 2024a). The King orange variety is recognized as a key economic crop in the district, helping many farmers establish stable livelihoods, escape poverty, and achieve wealth through agricultural production. However, in recent years, many orange orchards have experienced significant degradation due to uncoordinated planning, limited investment in intensive farming, and improper application of genetic conservation techniques. These factors have led to uneven fruit quality, sour fruit, and a high seed count. Moreover, the orange market lacks a stable export outlet, and domestic consumption remains volatile (Huyen et al., 2024).

To ensure sustainable cultivation, Bac Quang district has proposed several solutions, one of which is the promotion of digital transformation in orange production. The implementation of digital transformation is essential for expanding the consumption market, increasing labor productivity, reducing input costs, improving product quality, and mitigating production risks. However, there are still significant challenges in applying digital transformation to agriculture in general and orange production in particular in Bac Quang district. This paper aims to assess the current situation and propose strategies to facilitate the adoption of digital transformation in orange cultivation in Bac Quang district, Ha Giang province.

2. Methodology

This article employs the methods of investigation, synthesis, processing, comparison, and data analysis. The research gathers relevant policies and regulations on digital transformation issued by the Prime Minister, the Ministry of Agriculture and Rural Development, the Executive Committee of the Bac Quang District Party Committee, and the People's Committee of Ha Giang Province. Secondary data on the state of orange production and its degradation were obtained from the Bac Quang District Department of Agriculture and Rural Development. To identify constraints and their causes related to digital transformation in orange cultivation, an unstructured, in-depth interview method was utilized, targeting 30 participants, including specialists from the Bac Quang District Department of Agriculture and Rural Development, civil servants involved in agriculture, construction, and environmental management in communes with significant orange cultivation, as well as orange orchard owners. Both primary and secondary data were processed using Microsoft Excel software. The analysis and comparison methods were applied to evaluate the issues addressed in the study.

3. Results and Discussion

3.1. Current status of orange production in Bac Quang

Three major orange varieties of King, Vinh, and V2 are cultivated in the orange-growing regions of Ha Giang province, particularly in Bac Quang district. King orange occupies the largest area with 1,901.65 hectares (accounting for 61.38% of the total), followed by types of early and medium ripe oranges (CS1, CT36, Vinh, Cao Phong, Xa Doai, etc.) with 1,064.50 hectares (34.36%), and types of late ripe orange

(V2) with 131.83 hectares (4.28%). According to the People's Committee of Bac Quang (2024a), the communes of Vinh Phuc, Tien Kieu, Dong Thanh, Vinh Hao, Dong Yen, Dong Tam, and Vinh Tuy serve as the primary locations for orange cultivation. Vinh Phuc commune alone accounts for more than 31% of the district's total orange-growing area, with 967.38 hectares of cultivated land and 910.85 hectares of harvested area. Although oranges are now grown in all administrative units of the district, but they will primarily focus on places with strong potential for citrus fruit development, including Dong Thanh, Dong Yen, Tien Kieu, Vinh Phuc, Vinh Hao, Tan Thanh, Dong Tien, Viet Hong, Vinh Tuy, and Viet Quang. This aligns with the "Project on Planning Citrus Trees in the District Until 2025, with a Vision to 2030," and the "Planning for Developing Commodity Production for Key Products with Strengths in Bac Quang District during the Period of 2017-2020, with a Vision to 2025". Many cooperatives and cooperative groups have been established to facilitate orange production and consumption. The transition from intensive farming to circular farming that adheres to VietGAP and organic standards has become widespread. Orange products are sold through various channels, including cooperatives, electronic trading platforms, supermarkets, and wholesale markets in Gia Lam, Ha Dong (Hanoi); Hai Phong; Bac Ninh; and Vinh (Nghe An). Orange products from the Bac Quang region have gradually gained a foothold in the domestic market, providing a stable income source for orange growers.

Table 1: Status of orange production in Bac Quang district in the period 2021-2023

Criteria	King orange	Types of early and medium ripe oranges	Late ripe orange	Total
Cultivated area	1,901.65	1,064.50	131.83	3,097.98
Harvested area	1,876.82	981.20	104.83	2,962.82
Productivity	10.45	11.14	9.94	10.66
Yield	19,614.23	10932.15	1042.45	31,588.83

Source: People's Committee of Bac Quang, 2024a

The permanent crops in Bac Quang district include orange trees, particularly the King orange variety. A significant portion of the orange-growing areas is characterized by steep topography, making the processes of planting, maintaining, and harvesting highly labor-intensive. Currently, most orange growers rely on manual methods for harvesting, weeding, fertilizing, pesticide application, and irrigating their orange trees. Survey results reveal that only a small proportion of households, primarily in areas with relatively moderate terrain and better economic conditions, have invested in irrigation systems for orange cultivation. In recent years, many orange-growing regions have deteriorated due to various factors, including fungal infections, nutrient deficiencies, climate change, and inadequate care. According to the People's Committee of Bac Quang (2024b), 2,085.89 hectares of degraded oranges are currently in 177 villages/residential groups. Of these, 648,63 hectares (31.10%) are classified as level I degradation, 660.96 hectares (accounting for 31.68%) as level II degradation, and 776.31 hectares (37.22%) as level III degradation (Table 2).

Table 2: Degraded orange area in Bac Quang district

Types of orange	Level I	Level II	Level III	Total
King	483.04	409.37	665.84	1,558.24
Vinh	153.26	244.04	104.52	501.82
V2	12.33	7.55	5.95	25.83
Total	648.63	660.96	776.31	2,085.89

Source: People's Committee of Bac Quang, 2024b

The survey results indicate that the majority of orange trees in Bac Quang district degrade between the ages of five and fifteen. The primary causes include the use of improper technical practices, planting orange trees on hills and steep slopes that lead to leaching and erosion during the rainy season, and the over-application of nitrogen and imbalanced fertilizers. Furthermore, three major diseases root rot, yellow leaf disease, greening, and Tristeza have severely impacted many orange orchards. The degradation of these trees has significantly reduced the income of orange growers. In response, the district’s agricultural extension agency and agricultural sector have organized awareness campaigns, training, and technical guidance. These initiatives encourage the use of balanced and appropriate fertilizers, with a focus on organic fertilizers and biological pesticides instead of herbicides. They also promote regular garden maintenance, the removal of diseased trees, pruning, and other practices aimed at limiting orange tree degradation and improving land use efficiency. For areas experiencing level I degradation, growers should be supported and guided in using technical solutions to restore their orange orchards. However, in areas with level II degradation, where restoration is more difficult, and level III degradation, where recovery is not feasible, it is recommended that farmers proactively switch to more suitable crops, such as other fruit trees or forestry. They should also receive support for inputs and collaborate with companies to access seed varieties for households transitioning to medicinal plant cultivation. To assist farmers in making informed decisions about investments and orange production, authorities at all levels must enhance their knowledge and forecasting capabilities related to weather, pests and diseases, and consumer markets.

3.2. The current status of digital transformation in orange cultivation in Bac Quang district

3.2.1. Policies and laws on digital transformation related to orange cultivation in Bac Quang district

Recognizing the inevitability of digital transformation, especially in the context of the Fourth Industrial Revolution, the 13th National Party Congress emphasized the need to robustly support national digital transformation efforts, advance the digital economy, and foster a digital society. These efforts aim to enhance productivity, quality, efficiency, and competitiveness within the economy. The Congress outlined a goal of developing a digital economy and government that will contribute approximately 30% to GDP by 2030. In the domains of e-government and the digital economy, Vietnam currently ranks third in ASEAN and aspires to be among the top 50 countries globally.

On June 3rd, 2020, the Prime Minister of Vietnam issued Decision No. 749/QD-TTg, which approved the "National Digital Transformation Program to 2025, with a Vision to 2030." This program identifies agriculture as one of the eight priority sectors for digital transformation, with specific directions including (i) Developing a high-tech agricultural sector focused on precision farming, smart agriculture, and increasing the contribution of digital agriculture to the economy; (ii) Building a data platform for agriculture that encompasses land, crops, livestock, and aquatic products. This includes establishing a network of integrated ground and aerial surveillance systems to support agricultural activities, facilitating the exchange of agricultural equipment via digital platforms, and providing farmers with information on weather, environmental conditions, and soil to enhance crop productivity and quality; (iii) Utilizing digital technology to automate business and production processes, manage and monitor product origins and supply chains, ensuring speed, accuracy, transparency, safety, and food hygiene. Additionally, training in digital technology use for agricultural production, supply, distribution, and forecasting (e.g., price, season) is encouraged, along with the promotion of e-commerce within the agricultural sector; (iv) Implementing a comprehensive digital revolution in management to ensure timely and effective policies for agricultural development.

The Vietnam Ministry of Agriculture and Rural Development's digital transformation plan for 2025, with a vision extending to 2030, aims to promote the increased use of digital technologies in agricultural production, services, origin management, and monitoring, thereby fostering the creation of a digital agricultural ecosystem. The plan sets a target for 80 percent of agricultural databases to be established and updated on big data platforms by communities, businesses, and individuals. The plan emphasizes the completion of databases for crops, livestock, and aquatic products, the development of a digital agricultural map to facilitate data sharing and online public services, the advancement of e-government, and the integration of Internet of Things (IoT) technology to support agricultural activities.

In line with Central Committee directives, the Provincial Party Committee of Ha Giang issued Resolution No. 18-NQ/TU on October 29th, 2021, outlining the digital transformation strategy for 2021-2025 with a vision toward 2030. The objective is to generate new growth opportunities in socio-economic development, enhance labor productivity and competitiveness, and transform business models within the global supply chain. The resolution also aims to support the successful implementation of three breakthrough areas and five key tasks identified by the 17th Provincial Party Congress, with the ultimate goal of establishing Ha Giang as a significantly developed socio-economic entity in the northern midland and mountainous region by 2030 (Ha Giang Provincial Party Committee, 2021).

Ha Giang province has initiated its digital transformation efforts through Resolution No. 18-NQ/TU and several subsequent cooperation agreements for 2021–2025. Key legal frameworks include Plan No. 293/UBND dated December 7th, 2021, which addresses digital transformation and information security for 2022; Plan No. 293/KH-UBND dated December 7, 2021, implementing Resolution No. 18-NQ/TU; and Plan 301/KH-UBND dated December 30th, 2022, for digital transformation in 2023 (People's Committee of Ha Giang Province, 2021a, 2021b, 2022). Additionally, the province has established village-level digital technology teams, provincial and district executive committees, and commune-level digital transformation steering committees.

In Bac Quang district, Resolution No. 04-NQ/HU dated February 26th, 2021, focuses on developing citrus fruit trees through 2025 and includes provisions for creating a website to promote e-commerce and connect with national and provincial e-commerce platforms, as well as ensuring effective management of traceability stamps. To leverage regional potential and drive economic growth, the District Party Executive Committee issued Resolution No. 07/NQ-HU on October 11th, 2016, on developing key commodity production, and Resolution No. 05/NQ-HU on May 28th, 2021, focusing on key products according to the value chain for 2021–2025. Among the district's key economic products, orange cultivation stands out, requiring the adoption of technological solutions and digital transformation to enhance added value.

These policies and regulations provide a foundational framework for Bac Quang district's efforts to promote digital transformation in the production, marketing, and consumption of orange products, thereby improving economic efficiency and supporting the sustainable growth of the district's orange-growing areas.

3.2.2. Current status of orange cultivation linked with digital transformation in Bac Quang district

Bac Quang district has actively promoted the adoption of digital transformation among businesses, cooperatives, and orange-growing households to enhance the production, marketing, and consumption of orange products. This initiative recognizes digital transformation as a crucial strategy for modernizing production methods, optimizing labor, reducing costs, and improving overall production efficiency, product quality, and farmer incomes. The Ha Giang province agricultural sector has facilitated this by providing digital accounts to households, leaders, and officials for routine updates on product information, particularly for King oranges. In response, the Bac Quang district People's Committee has implemented e-commerce and digitized industrial processes through a traceability system, allowing customers to access comprehensive product information and manufacturing details via QR codes. Since early 2021, Bac Quang district has organized numerous training sessions on digital transformation for businesses, cooperatives, and households to enhance their digital capabilities. This has enabled them to be more proactive, increase competitiveness, and plan efficient production strategies. In 2023, the Department of Industry and Trade, in collaboration with local People's Committees and Viettel Ha Giang, arranged training for various stakeholders on leveraging digital transformation and information technology to market agricultural products online. All OCOP (One Commune One Product) items, including oranges, now have listings on major e-commerce platforms such as Sendo, Voso, and Postmart. Additionally, Bac Quang district has integrated digital transformation into public administration, education, and business support sectors. This includes promoting the use of e-commerce platforms like Sendo and Voso for orange marketing, establishing 236 community digital technology groups to assist with online public services, and encouraging the use of digital tools for administrative tasks and electronic payments. Many local orange producers have embraced internet platforms for promoting and selling their products, using social media and live-streaming to increase sales, enhance transparency, and reduce intermediary costs.

Since 2022, the Bac Quang District People's Committee has collaborated with relevant agencies and units to establish a digital-integrated orange garden model. This model aims to support farmers in the intensive cultivation of oranges through the adoption of advanced scientific and technological methods, enhancing both the quality and value of the product. Currently, five households from Vinh Phuc, Tien Kieu, Vinh Hao, and Viet Quang towns have cultivated 20 hectares of oranges under this model. Participants receive 50% financial support for the purchase of biological insecticides, organic microbial fertilizers, weed seeds, and lime powder for trunk treatment. The criteria for orange gardens to qualify under this digital transformation model include (i) A minimum area of 3.0 hectares, accessible traffic routes, a planting density of 400–500 trees per hectare, trees aged between 5 and 15 years, and healthy growth; (ii) The presence of a visible garden diagram to facilitate educational and observational activities; (iii) Adoption of environmentally friendly and organic production methods, including the application of scientific techniques such as planting wild peanuts to improve soil moisture and reduce weed impact, installing an irrigation system, and adhering to VietGAP standards or a secure supply chain for yellow oranges; (iv) Utilization of product tracking stamps, production linkages, and regional indicators, particularly for King oranges; (v) Implementation of digital tools to monitor product origin, maintain an electronic cultivation diary, facilitate online sales, and promote products through social media and internet platforms. Participants update their cultivation records using the Digital Authentication Technology Joint Stock Company's software, documenting activities such as fertilization, branch pruning, lime brushing, pesticide application, moisture retention through peanut grass, and pest and disease management.

The application of digital transformation in orange production and consumption has helped orange growers access science and technology in production. Specifically, when orange trees are unhealthy, growers can call and livestream the status of the orange garden to consult with scientists on how to resolve the disease situation. In turn, it enhances the productivity, output, value, and income of orange producers. In addition, the introduction of orange products on e-commerce platforms and social networking sites has contributed to the increase in the consumption of orange output, the reduction of challenges for producers, the creation of convenience, information transparency, and the reduction of intermediary costs. Simultaneously, it has fostered a chain of links, fostering the close and multidimensional collaboration between management agencies, businesses, and farmers, resulting in the development of products that satisfy the growing demands of the market and consumers, while also ensuring quality, safety, and responsibility.

Numerous studies have demonstrated that digital transformation is necessary for sustainable agricultural development and to promote green growth in agriculture. According to Mustashkina et al., (2020), the digitalization of agricultural production in the Russian Federation is expected to result in a 1.5-fold increase in crop and livestock production by 2025, as well as an improvement in product quality, a 1.5-fold reduction in the labor intensity of the agricultural output, a reduction in costs and prices, decreased energy and material consumption, a reduction in the reliance on imports for agricultural machinery, their hardware, and software, and the advancement of automation, robotization, and intelligent machine technology. The Internet of Things (IoT) and sensors are efficient instruments for enhancing food security and agricultural sustainability (Morchid et al., 2024). Furthermore, using digital technology can lower information search, transaction, transportation, and risk aversion costs for agricultural operators (Zhang et al., 2021). E-commerce raises agricultural revenues and makes it easier for farmers and customers to communicate directly (Ji et al., 2023; Vavekanand and Kumar, 2024; Qin and Fang, 2022), reduces regional poverty in rural areas (Qin and Fang, 2022), and gives rural women more power (Yu and Cui, 2019). Moreover, the application of digital transformation also contributes to decreasing carbon emissions (Chen and Li, 2024), promoting green growth in agriculture (Shen et al., 2022). The nonlinear relationship between the digital economy and carbon emissions was validated in research by Bai et al. (2023) and Dong and Zhou (2023).

The proactive adoption of digital transformation in the management, production, commerce, and consumption of oranges is instrumental in fostering the efficient and sustainable growth of Bac Quang district's agricultural sector. However, survey results reveal several challenges and barriers to its implementation. These include (i) the limited scale of digital transformation initiatives, which discourages widespread farmer participation; (ii) inadequate infrastructure that does not meet the requirements for digital transformation; (iii) financial constraints and insufficient awareness among some individuals, hindering the adoption of advanced technologies by businesses and cooperatives; (iv) a shortage of highly skilled human resources in agriculture; and (v) the limited number of orange cultivation models currently utilizing digital transformation.

3.3. Solutions to facilitate the implementation of digital transformation in the orange cultivation of the Bac Quang district

To encourage organizations and enterprises to provide digital services in agriculture, it is essential to review and refine existing policies. Implement policies that incentivize businesses to collaborate with orange growers and invest in developing model orange orchards integrated with digital transformation. This approach will improve the quality of orange gardens, ensuring they meet green and organic agriculture standards.

Additionally, it is crucial to enhance and complete a modern, cohesive digital technology infrastructure to support the connection, utilization, and sharing of data related to orange production and consumption. This includes gathering all digital data necessary for planning orange-growing areas, such as land characteristics and properties. Encourage individuals, businesses, and cooperatives to digitize their orange production processes. Ensure the completion of the orange traceability information system, encompassing all ten essential pieces of information, by Circular No. 02/2024/TT-BKHCN (Vietnam Ministry of Science and Technology, 2024). Develop fully integrated software to optimize the management and utilization of digital data in orange production and consumption.

It is essential to enhance the awareness of the role and significance of digital technology in the production, management, business, and consumption of oranges among authorities at all levels, businesses, cooperatives, and farmers. Increased focus from all sectors on training and improving digital skills for farmers is crucial to facilitate digital transformation. Adequate human resources, including officials, civil servants, business owners, cooperatives, and farmers, are vital for successful digital transformation. It is imperative to ensure that a sufficient number of individuals possess high-quality professional qualifications and receive appropriate training in digital transformation, management, and production direction, particularly for civil servants and officials. Business owners, cooperatives, and individual producers must not only have a thorough understanding of the agricultural market but also the ability to anticipate market supply and demand trends to make informed decisions about expanding agricultural production areas. This knowledge should complement their understanding of digital transformation.

Diversify orange products by investing in state-of-the-art technologies for processing and preservation. Enhance agricultural credit facilities, particularly loans targeted at agricultural value chains, to unlock additional capital for digital transformation and innovation in agriculture. Additionally, ensure that the post-investment support policy stipulated in Decree 57/2018/ND-CP is revised to include a disbursement mechanism for each item, ensuring timely capital support for businesses investing in digital technology applications in agriculture.

Strengthen the research, application, and transfer of scientific and technological advancements into agricultural production. Implement modern and innovative technologies across the entire spectrum of production, harvesting, preservation, processing, transportation, and consumption of agricultural products. Encourage enterprises to adopt technical innovations, integrated pest management (IPM) programs, integrated crop management (ICM) programs, and improved cultivation practices. Promote agricultural extension programs, enhance awareness, and advocate for safe crop production through VietGAP standards.

4. Conclusion

The orange tree is considered a key economic crop in Bac Quang district, with a total area of 3,097.98 hectares. The King Orange occupies the largest area, totaling 1,901.65 hectares. Currently, many orange orchards are experiencing degradation due to factors such as improper technical practices, excessive nitrogen and imbalanced fertilizer application, and severe diseases. To ensure sustainable cultivation, Bac Quang district has proposed several strategies, including the promotion of digital transformation. Digital transformation is recognized as a potent method to enhance the income of orange growers and facilitate their access to advanced scientific and technological practices. However, there are notable barriers to effective digital transformation, including limited scale of implementation, inadequate infrastructure, financial constraints, lack of awareness, and a shortage of skilled personnel. To advance the application of digital transformation in orange cultivation, several key measures must be undertaken: developing and implementing a modern and integrated digital technology infrastructure; (ii) raising awareness among farmers, businesses, and cooperatives about the benefits of digital transformation; investing in state-of-the-art technologies for processing and preservation; strengthening research, application, and dissemination of scientific and technological advancements in agricultural production.

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Digital Transformation of the Food and Beverage Industry with QR code Towards Sustainable Development in Vietnam

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Abstract

This paper investigates the rapid adoption and evolving trends of Quick Response Code (QR) technology in the food and beverage (F&B) industry, with a focus on both global and Vietnamese markets. It examines how QR codes facilitate cashless payments, enhance customer experiences, and support sustainable practices. Statistical analysis shows that while QR codes improve order efficiency, the payment process remains inefficient. Additionally, paper receipt waste costs average close to 30%, undercutting the eco-friendly potential of QR codes. The study evaluates various restaurant management software platforms, finding consistent results across these systems. It proposes the integration of dynamic QR codes with IoT, innovative solutions, and policy enhancements to drive digital transformation and sustainable growth in Vietnam's F&B industry.

Keywords: *Sustainable development, green growth, QR code, cashless payment, IoT*

1. Introduction

In contemporary business sectors, the pursuit of sustainable development has motivated enterprises to seek advanced technological solutions that mitigate environmental impact while enhancing operational efficiency. Among these, QR code technology has garnered significant attention as a powerful digital tool capable of optimizing various business processes. QR codes not only streamline payment procedures and service operations but also play a pivotal role in reducing paper consumption, contributing to a company's sustainable development strategy (Ozturkcan & Kitapci, 2023).

A QR code (Quick Response Code) is a type of matrix barcode, developed by the company Denso Wave in Japan in 1994 (Firstarine et al., 2022). It can be scanned by barcode readers or smartphones with camera functionality and a specialized application. QR Codes can store information such as web addresses, contact details, SMS messages, text content, product introductions, and location data. Designed with high error tolerance, QR Codes can be decoded even when partially damaged, making them versatile tools in various fields, from electronic payments and advertising to inventory management and supply chain logistics.

QR Code are categorized into two main types: Static QR Code and Dynamic QR Code, each with distinct features and applications. Static QR Code contain fixed information that cannot be altered once generated and printed. Common applications include contact information on business cards, URLs leading to websites, product pages, or promotional content. While simple and easy to use, the primary limitation of Static QR Code is their immutability, which makes updating information challenging. Dynamic QR Code, on the other hand, allow the encoded content to be modified without reprinting the QR Code. The information in a Dynamic QR Code is stored on a server and can be updated at any time.

QR Code technology has brought about substantial changes in the F&B (Food & Beverage Service) industry, enhancing service efficiency, improving customer experiences, optimizing restaurant operations, and reducing the reliance on printed materials (Ozturkcan & Kitapci, 2023; Gupta et al., 2023). QR codes have become essential for ordering and payments, enabling customers to scan codes to access digital menus, place orders, and make payments directly at their tables. The application of QR codes not only helps reduce waiting time but also lessens the workload for service staff, thereby enhancing the operational efficiency of the restaurant (Nikose et al., 2023; Gupta et al., 2023). QR codes are also utilized in marketing campaigns, customer data collection, and food traceability, offering transparency and promoting sustainable practices. The COVID-19 pandemic has further accelerated the adoption of QR codes due to their ability to minimize physical contact and ensure hygiene in restaurants.

QR codes have become a crucial tool in many global industries, with a significant increase in frequency and scope of use. Brands and businesses of all sizes have leveraged QR codes to create more meaningful connections. According to Bitly's 2023 report, there are several noteworthy trends: (i) The first trend is the global surge in QR code adoption. In 2023, QR codes experienced double-digit growth as businesses recognized their value. Since the COVID-19 pandemic, QR codes have become a bridge between physical and digital realms, enhancing consumer interaction and experience. In the first half of 2023, the number of global QR codes increased by 41% compared to the same period the previous year. (ii) The second trend is that QR codes are driving digital experiences across industries worldwide. The Restaurant and Entertainment sectors lead with a growth rate of 187% from 2022 to 2023 (Bitly, 2023). (iii) The third trend is the use of QR codes to promote sustainable business practices and reduce environmental impact. QR codes enable businesses to share transparent information about production and distribution processes, reduce printed materials, and promote eco-friendly initiatives (Bitly, 2023).

QR code technology has had a profound impact on the F&B industry, particularly in the context of the COVID-19 pandemic and the subsequent recovery phase. The innovative applications of QR codes not only focus on improving customer experience but also help optimize restaurant management processes, enhance sustainability, and meet the growing demand for food safety and traceability information. During the COVID-19 pandemic, QR code technology significantly impacted the F&B industry, especially with the implementation of social distancing measures. Riteshkumar Singh on ITM Web of Conferences reported that in this context, QR code-based restaurant management and payment systems were developed to replace manual ordering processes (Singh, Sonje, Salkar, & Jadhav, 2022). This system facilitates communication between customers, staff, and the kitchen, aiming to replace traditional manual ordering processes while supporting restaurant owners in analyzing data to increase sales and improve customer experience, with dish recommendations that could enhance customer loyalty to the restaurant. Nikose et al. (2023) proposed a QR code ordering system that allows customers to scan a code on the table to place orders directly, eliminating the need to wait for staff (Nikose, Hatwar, Nikose, Adikane, & Gaharwar, 2023). The order is then sent to the kitchen, saving service time and improving the order intake process.

Ozturkcan (2023) mentions that QR code menus help restaurants save costs and resources by eliminating the need for printing and handling paper menus (Ozturkcan & Kitapci, 2023). Customers can conveniently access menus and place orders by scanning QR codes. It also helps reduce food waste by promoting items that are nearing expiration and encouraging customers to purchase them. Additionally, QR code menus provide detailed information about ingredients and food sourcing, encouraging environmentally-friendly food choices. Managers can use data from QR codes to optimize inventory and supply chains, reducing waste and costs. It also supports organic and local food producers by providing information about the origin and environmental benefits of the food.

The latest technological achievement related to the use of QR codes in the F&B sector from DIWA company is the smart technology product Digital e-Chalkboard Viewneo, integrated with the Internet of Things (IoT) technology. This allows restaurants to automatically transmit information via radio waves and display dynamic QR codes directly to individual tables. Not only does this enable customers to quickly scan the code to order or pay via QR code at the table, but it also allows for easy personalization and customization by creatively transmitting marketing messages, promotions, congratulations, and more. This technology combines dynamic QR codes with IoT, helping restaurants increase the opportunity to activate more touchpoints throughout the customer journey from the moment they sit down at the table, in an efficient, flexible, and measurable.

2. Methods

The research method of this paper primarily relies on analyzing existing software systems to evaluate the current popular restaurant management technology solutions in Vietnam. In the F&B business sector in Vietnam, restaurant management software companies have also made efforts to apply QR code technology. Notable examples of restaurant software such as POSAPP, MISA Cuk Cuk, and KiotViet have integrated functions for ordering at the table and QR code payment. Consequently, the research team conducted a survey and analysis of these three popular restaurant management software. This analysis aims to understand the structure and common processes of systems related to QR code technology. This helps the research identify the strengths and limitations of existing solutions, thereby proposing necessary improvements or integrations to optimize management processes and enhance customer experience, promoting digital transformation and sustainable growth in the F&B industry.

The study further involved quantitative data collection from six restaurants in Ho Chi Minh City, where POSAPP, MISA Cuk Cuk, and KiotViet systems were implemented. Surveys targeting restaurant managers and staff were conducted to evaluate performance metrics such as average order speed by QR Code menu, average QR Code payment completion times, and paper receipt waste costs. This data was analyzed statistically, focusing on operational efficiency and system effectiveness. By examining these aspects, the research aimed to assess the strengths and weaknesses of the existing solutions, supporting recommendations for enhancing digital transformation in the F&B industry.

3. Results

3.1. An overview of QR code usage in Vietnamese

As the trend of smartphone usage in Vietnam continues to grow, QR codes have become increasingly widespread across the country, particularly in the restaurant industry. QR codes are most commonly used for cashless payments in both business sectors and restaurants in Vietnam. With a simple, fast, and cost-effective method, QR Code payment is increasingly being chosen by many customers, as well as banks and financial companies, which are focusing on research, investment, and development (Bitly, 2023). Systems like VietQR, VNPay, MoMo, ZaloPay, etc., have become the preferred QR code payment methods for many Vietnamese people. According to the latest data from the State Bank of Vietnam at the Press Conference Announcing the Digital Transformation Event of the Banking Sector in 2024, in the first two months of 2024, non-cash transactions increased by 59.6% in volume and 32.73% in value compared to the same period in 2023. Specifically, payments made through the Internet grew by 51.60% in volume and 23.88% in value, while payments through mobile phones increased by 63.24% in volume and 33.43% in value. Remarkably, QR code payments saw a staggering increase of 846.41% in volume and 1,146.14% in value (Linh, 2024). Despite being a relatively new method compared to others, QR code payments have quickly become the most popular cashless payment option in Vietnam.

The growth of cashless payments has a positive outcome in reducing the amount of cash circulating in the economy. According to the State Bank, the amount of cash in circulation in the economy at the end of August 2023 was over 1.289 million billion VND, a decrease of nearly 63.800 billion VND compared to the end of 2022. The significant reduction in cash circulation, amid the continuous strong growth of electronic payments in recent years, has led to a decrease in social waste related to environmental protection issues such as the costs of printing, preserving, transporting, and destroying money.

The world’s leading electronic payment technology company, Visa, conducted a study on consumer payment attitudes in 2023, surveying 6,550 consumers in Singapore, the Philippines, Malaysia, Indonesia, Thailand, Vietnam, and Cambodia. The report highlights the impressive growth of cashless payment methods, with Vietnam leading the digital payment transformation in Southeast Asia, as 88% of consumers switched to cashless payments in 2023. According to Visa, the growth momentum of cashless payment methods, particularly through QR codes and e-wallets, in Vietnam is evident in sectors such as F&B, retail, and convenience stores. Among these, the acceptance rate of digital payments in Vietnam’s F&B sector saw the strongest growth, leading with a rate of 79% (VISA, 2024).

3.2. Survey results of QR code application software

The authors have researched and examined three popular restaurant management software solutions from leading software companies in Vietnam.

KiotViet’s Restaurant Management Application (since 2014, serving over 200,000 stores) operates on the WebApp platform at https://fnb.kiotviet.vn, integrating an electronic menu function that allows customers to easily select dishes, place orders, and make payments directly at the table via QR code. Restaurant owners can enable the electronic menu feature on the sales website, print QR codes to place at tables for customers to scan and view the menu. When customers place an order, the system automatically sends the information to the cashier and kitchen for processing. KiotViet also supports bank transfer payments via VietQR code, displayed on the invoice or through the QR display screen – KV68 connected via USB to the sales computer.

PosApp's Application (since 2014, supporting 30,000 restaurants and eateries) includes management software on the Web platform (https://posapp.vn) and PosAppPC, effectively managing business operations. A standout feature is the electronic menu integrated with QR codes, allowing customers to easily select dishes and make payments directly at the table, minimizing errors and saving service time. Store owners can set up static QR codes at each table, allowing customers to scan the code with their phones to place orders. PosApp supports various digital payment methods via QR codes such as MoMo, VnPay, ZaloPay, and Payoo, ensuring flexibility and convenience in transactions.

MISA CukCuk Application: Although only introduced in 2017, MISA CukCuk has quickly become one of the popular restaurant management software in Vietnam. The software runs on the Windows operating system, supporting order management through QR electronic menus at the table, generating corresponding QR codes for each table for the restaurant to print and place at the table. This allows customers to place orders from their mobile devices without the need for staff assistance. This software system also integrates QR code payment for bank transfers in the invoice, making it easy for customers to pay directly at the table. Currently, CukCuk connects with Techcombank's API, allowing restaurants to perform automatic reconciliation.

During the field survey at restaurants using the aforementioned software, the research team observed that, besides the advantages QR codes bring to restaurants, such as enhancing order efficiency and convenient payment, there are still some limitations in applying QR codes in this field: (i) Disadvantages of static QR code payment at the table: Static QR codes are at risk of being replaced by fake codes, compromising security. Diners must manually enter the amount or transfer details, which can lead to errors and time consumption. (ii) Bottlenecks in dynamic QR code payment on the bill: When the restaurant is crowded, diners have to wait for staff to bring the provisional bill with a QR code. Staff spend time capturing transaction screenshots for reconciliation. (iii) Limitations in ordering via static QR code menus at the table: Static QR codes can be misused for remote ordering, causing management disruptions.

The quantitative data in the table below presents performance metrics across six restaurants, specifically focusing on QR Code Order Speed (seconds), QR Code Payment Time (seconds), and Paper Receipt Waste Costs (%).

Table 1: Restaurant Performance Analysis – Order Speed, Payment Time, Paper Receipt Waste Costs

Restaurant	QR Code Order Speed (seconds)	QR Code Payment Time (seconds)	Paper Receipt Waste Costs (%)	Management Software
1	288	396	27	*KiotViet*
2	348	408	29	*PosApp*
3	336	384	32	*MISA CukCuk*
4	324	378	28	*KiotViet*
5	312	354	33	*PosApp*
6	282	402	30	*MISA CukCuk*
Average	**315**	**387**	**29.83**	
Standard Deviation	**26.22**	**19.63**	**2.32**	

Source: Author

Based on the statistical data presented, the average QR Code Order Speed across all restaurants is efficient, with a mean of 315 seconds and a standard deviation of 26.22, indicating relatively consistent performance. However, the average QR Code Payment Time of 387 seconds, with a smaller standard deviation of 19.63, points to inefficiencies in the payment process, which could frustrate customers. Additionally, the average Paper Receipt Waste Cost of 29.83%, with a standard deviation of 2.32, highlights a significant reliance on printed receipts, undercutting the eco-friendly benefits of QR code technology. These findings suggest that while digital integration has improved order efficiency, there is a clear need to streamline payment processing and reduce the environmental impact of paper use. Notably, these results are consistent across different management software used by the restaurants. Addressing these two weaknesses could enhance overall system performance and support more sustainable operations in the F&B sector.

General procedures for QR code usage in management softwares

After researching the process of applying QR codes for table ordering and payment in three popular software solutions, the authors analyzed and identified commonalities and generalized the QR code application process. This serves as a basis for identifying limitations, thereby improving the current restaurant operation process.

Ordering and service process via QR code digital menu

The typical process for ordering via QR code electronic menus in restaurants using the management software mentioned in section 3.1 operates according to a general six-step procedure as illustrated in Figure 1: (1) The restaurant creates a digital menu with images of food and beverages on the website; (2) The restaurant generates unique QR codes for each table; (3) Customers scan the QR code with their smartphones, which directs them to the digital menu on the website where they can select their dishes; (4) Customers pay for their orders using their preferred payment method (QR code, credit card, debit card, cash). (5) The order is received by restaurant staff and confirmed to avoid fraudulent orders. The food order is automatically sent to the kitchen printer, while the drink order is sent to the bar printer; (6) The restaurant prepares the order and serves the food and beverages to the customer at the table.

Figure 1: Ordering and service process via QR code digital menu

Source: Author

In this process, depending on the restaurant's operational regulations, customers may be required to pay before or after their order is confirmed, resulting in two separate flows: Pre-payment and Post-payment. Accordingly, the sequence of steps in these two flows will differ at steps (4), (5), and (6) as illustrated in Figure 1.

Advantages of QR code electronic menus include saving paper and ink, contributing to waste reduction and environmental protection. However, it also presents a limitation identified by the research group in section 2: anyone with an image of a static QR code for a restaurant table can place fraudulent orders. This issue is currently addressed by restaurant management software at a basic level in step (5), where staff manually review and approve orders before sending them to the kitchen. Such manual processing can create bottlenecks, causing delays and reducing the efficiency of restaurant operations, especially when serving many customers.

Dynamic QR code payment process

The dynamic QR code payment method in restaurants using the management software mentioned in section 3.2, as researched by the group, is carried out through an 8-step process as illustrated in Figure 2.

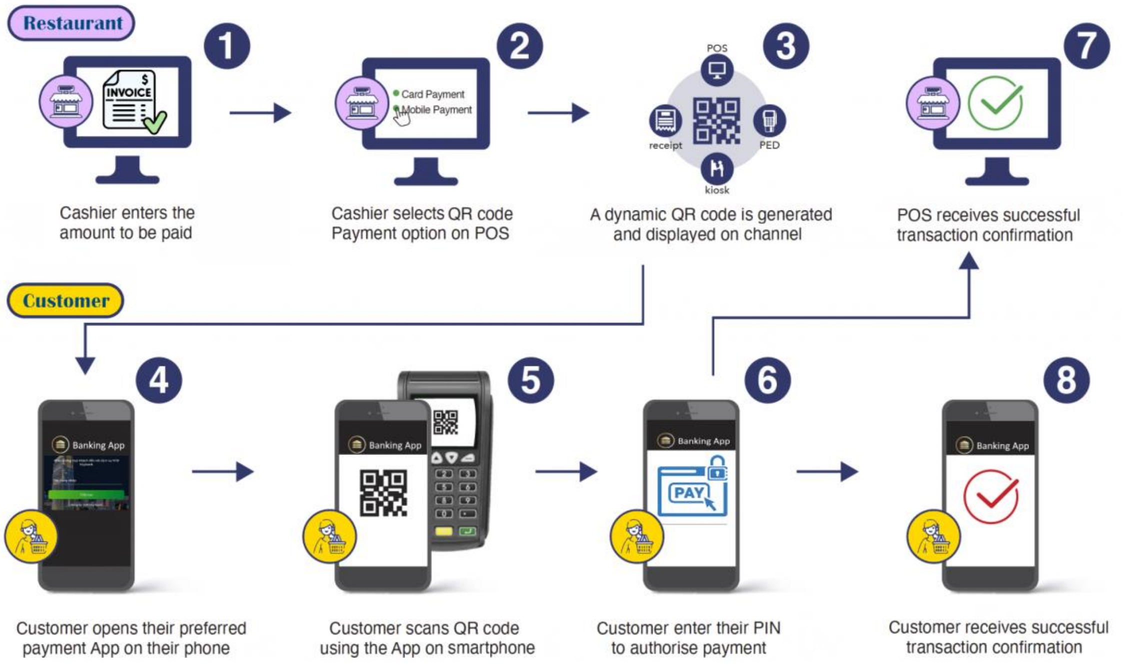

Figure 2: Dynamic QR code payment process

Source: Author

(1) When requested for payment by the customer, the cashier issues an invoice with the amount to be paid for the customer's table; (2) The restaurant cashier selects the option to pay via QR code scan on the management software; (3) A dynamic QR code for payment is generated and printed on the receipt (or displayed on the POS machine); (4) The customer opens the payment application on their smartphone; (5) The customer scans the QR code using the application; (6) The customer selects the account card and may be required to enter a PIN to confirm; (7) Once the payment is confirmed, the POS machine receives a successful transaction notification; (8) The customer receives a successful transaction notification via the application/SMS.

As shown in Figure 2 of this 8-step process, one limitation is when the restaurant cashier uses the software to generate a dynamic QR code for customer payment in step (3), which is then transferred to the customer to perform step (4) through a human-based method where the server carries the printed receipt with the dynamic QR code to the table for the customer to scan and pay. Such manual, human-based processing can create bottlenecks, reducing the overall operational efficiency of the restaurant, especially when it is overcrowded.

From an environmental protection perspective, printing receipts with dynamic QR codes also leads to paper and ink waste, contributing to increased waste. Each printed receipt impacts the environment, from resource use for paper production to waste disposal after use. This contradicts the goals of sustainable development and environmental protection. Instead, restaurants can use digital solutions such as displaying QR codes on IoT devices at the table, helping to minimize paper use and enhance operational efficiency.

Additionally, through research and analysis of these restaurant management software processes, the authors found that the application of QR codes to provide detailed information about the origin, production process, and organic certification of food used in preparation is not yet supported by the management software solutions. Customers have no convenient way at the table to check and trace this information, and restaurants have no way to transmit QR codes from food packaging in the kitchen to the customer's table to ensure transparency and trust in food quality.

4. Recommendations

Based on the analysis of trends and the current state of QR code usage in the F&B sector globally and in Vietnam in the previous sections, along with studies on the demand and feasibility of technology adoption, the research group proposes several recommendations to develop the application of dynamic QR code technology combined with IoT technology towards green and sustainable growth for restaurants in Vietnam.

Objectives

The goal of digital transformation in developing green and sustainable dynamic QR code technology applications in the F&B sector in Vietnam is to overcome the limitations mentioned in sections 2.3 and 3.2, including:

- *Enhancing customer experience:* Facilitating easy ordering, quick payment, and real-time updates throughout the dining experience. This will foster sustainable customer relationships with the restaurant, increasing business efficiency.
- *Optimizing restaurant management operations:* Minimizing errors in service, improving staff efficiency, and optimizing operational processes, thereby reducing restaurant costs.
- *Encouraging cashless payments:* Contributing to the government's cashless payment trend, reducing risks associated with cash handling, and simultaneously minimizing the state's printing of cash, which has sustainable development implications.
- *Promoting green growth:* Reducing the use of paper and other non-renewable resources in each restaurant, contributing to environmental protection and promoting sustainable development.
- *Supporting easy traceability of food origin and production processes:* Providing detailed information about the origin, production process, and organic certification of food used in the restaurant, ensuring customers' confidence in food quality and safety, and contributing to environmental protection.

When implementing dynamic QR code technology solutions in the F&B industry in Vietnam, practical considerations and reasonable inheritance must be taken into account to ensure effectiveness. Not all restaurants have modern infrastructure, so flexible, easily integrable solutions that do not require significant system changes are needed to minimize risks and costs. Inheriting existing systems is crucial as F&B businesses often invest in existing management systems and software, so new technology solutions must ensure compatibility and easy integration with current systems. This consideration will make the orientation towards green growth with dynamic QR code technology in the F&B industry more feasible, bringing practical and long-term benefits to both businesses and customers.

Recommendations for digital transformation with green dynamic QR codes

Developing a dynamic QR Code system integrated with IoT technology

IoT technology is making significant strides in the global F&B industry, especially when combined with dynamic QR codes. This integration not only brings convenience to customers and helps restaurants optimize their operational processes but also plays an important role in environmental protection in business. A well-developed IoT system can transmit dynamic QR codes to each dining table without the need for paper printing, allowing customers to easily order, pay, and receive personalized offers. An IoT product like the Digital e-Chalkboard Viewneo by DIWA, mentioned in section 1.2, is a prime example, as it can automatically update QR codes on the display screen at the table. This not only creates a smooth and convenient experience for customers but also helps restaurants manage service stages efficiently through QR codes displayed on IoT devices at the table instead of printing, thereby reducing paper usage, contributing to environmental protection, and promoting sustainable development.

Implementing an integrated IoT dynamic QR code system in Vietnam requires restaurants to invest in IoT infrastructure, including hardware devices such as display screens along with integrated management software. These devices need to be designed to synchronize with the restaurant's existing management system, allowing real-time updates of menu information, orders, payments, and other information. This not only helps minimize errors and save time but also increases transparency and efficiency in management, quickly meeting customer needs and thereby enhancing reliability.

A crucial factor for the success of this new system is collaboration with technology companies specializing in IoT and companies that own professional restaurant management software products. The combination of technology developers and restaurant managers will help create customized solutions that meet the specific needs of each business. Additionally, the new system needs to be built with scalability and easy integration with new technologies, helping to save deployment costs while leveraging existing technologies.

Research and implementation of innovative and green business practices

Based on the IoT and dynamic QR code technology mentioned above, technology companies need to research and develop innovative business methods and solutions not only to enhance customer experience but also to contribute to environmental protection. Below are some suggested ideas:

- *Introducing new dishes and green menus*: Dynamic QR codes on IoT devices at the table can be used to introduce new dishes and green menus, helping restaurants promote the consumption of clean, traceable food that adheres to sustainable standards. When customers scan the code, they are directed to a website or video detailing the dish, clean ingredients, and environmentally friendly preparation processes. This not only provides transparent information about the food supply chain but also promotes green consumption habits.
- *Cross-marketing products with green messages*: Restaurants can use dynamic QR codes on IoT devices to market other services, such as events or entertainment services, with messages encouraging the use of sustainable products and services. This not only helps increase revenue but also conveys environmental protection messages to customers, raising awareness about responsible consumption.
- *Sending congratulatory video clips and green gifts*: Using QR codes on IoT devices to send congratulatory videos for special events (birthdays, weddings, Valentine's Day, etc.) to loyal customers along with discount codes for eco-friendly products. This creates a positive experience, encouraging customers to use green products and build sustainable relationships with the restaurant.
- *Promotional programs and service reviews with sustainability commitments*: Dynamic QR codes on IoT devices can support promotional programs or invite service reviews while incorporating environmental protection messages. When customers participate in these activities, they have the opportunity to receive green gifts or learn about the environmental initiatives the restaurant is undertaking.

Implementing these solutions not only enhances service quality and business efficiency but also contributes to sustainable development strategies and environmental protection, helping restaurants strengthen their competitive advantage in the F&B industry.

API Integration and support for upgrading existing systems

Developing an integrated IoT dynamic QR code system requires the creation of flexible APIs to connect with existing restaurant management software, minimizing the costs of system upgrades. These APIs help synchronize real-time data, ensuring that information from the QR codes is instantly updated from the management software database to the IoT device screens. This not only allows restaurants to track orders and process payments smoothly but also facilitates the integration of new features without needing to overhaul the entire system.

Supporting system upgrades is crucial to ensure the feasibility and effectiveness of new technology solutions. Technology integrators need to work closely with restaurant managers to customize APIs and technology solutions to fit their needs.

Developing incentive policies and State support

The State can play a crucial role in promoting cashless payments and the application of green QR code technology in the F&B sector through incentive policies and financial support. One effective way is to support research and development of new technologies for startups in the IoT and Fintech sectors in Vietnam. Research funding programs, providing testing environments, and business incubators will help startups develop and test innovative solutions, contributing to green and sustainable growth.

Direct financial support from the state is also very important. Grants or low-interest loans for small and medium-sized enterprises (SMEs) will help them overcome capital difficulties when implementing new technologies. This is particularly important because many F&B businesses in Vietnam are SMEs that lack the resources to invest in advanced technology systems. The government can also provide tax incentives for businesses that implement new technologies, encouraging investment in dynamic QR code systems and IoT infrastructure, thereby reducing the use of non-renewable resources and protecting the environment.

In summary, state incentive policies and support will be key factors in promoting the application of dynamic QR code and IoT technology in the F&B sector in Vietnam. These measures not only reduce the financial and technical burden on businesses but also raise awareness of green growth and change consumer habits, creating a more modern, efficient, and sustainable business environment.

5. Conclusion

In this paper, we have presented the importance of dynamic QR codes in promoting digital transformation in the global F&B industry, while also contributing to green growth and environmental protection. We have analyzed the current state and trends of dynamic QR code technology application in Vietnam's F&B industry, emphasizing its role not only in improving customer experience but also in environmental protection, despite some limitations. Integrating this technology with IoT not only addresses these limitations, further enhancing business efficiency and customer experience, but also supports efficient resource use, minimizes negative environmental impacts, and promotes green growth for businesses and society as a whole.

To develop green dynamic QR code technology in Vietnam, collaboration between F&B businesses and technology companies, along with policy support from the state, is necessary. This will facilitate the research and implementation of new technologies, helping businesses overcome technical and financial challenges, and move towards a modern and sustainable economy. Proposed measures, such as developing integrated IoT dynamic QR code systems and establishing supportive policies, will be crucial foundations for advancing the F&B sector in Vietnam towards modernization and environmental protection. Digital transformation with dynamic QR codes is not only an effective solution for the F&B industry but also a significant direction for promoting green growth in Vietnam, contributing to creating an efficient and sustainable business environment.

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Sustainable Consumption through Electronic Word-of-Mouth: Opportunities for Green Brands in Vietnam

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Abstract

This article explores the role of electronic word-of-mouth (eWOM) in promoting sustainable consumption in Vietnam, a nation increasingly focused on environmental responsibility. With global and Vietnamese consumers prioritizing eco-friendly products, green brands can leverage digital platforms like social media and e-commerce to engage audiences. The rise of eWOM through online reviews, influencer marketing, and user-generated content is transforming consumer decision-making, driving the demand for sustainable goods. However, greenwashing, digital divides, and authenticity issues present significant challenges for eWOM campaigns. The article further discusses innovations in eWOM strategies, such as AI-driven reviews and blockchain, which enhance transparency and consumer trust. It examines how eWOM can help brands reach eco-conscious demographics, particularly millennials and Gen Z. The long-term potential of eWOM in shaping Vietnam's green market is highlighted, as continuous innovation and collaboration with influencers will be key in fostering environmental change. The article concludes by underscoring the need for authenticity and technological integration in eWOM to meet Vietnam's sustainability goals.

Keywords: *Sustainable consumption, social media marketing, environmental responsibility, greenwashing, influencer marketing*

1. Introduction

Sustainable consumption refers to the use of products and services in ways that minimize negative environmental impacts while promoting resource efficiency and social responsibility. It is a cornerstone of sustainable development, ensuring that future generations have access to essential resources. As environmental concerns grow, sustainable consumption has gained momentum globally. The *2021 Global Sustainability Study* reports that 85% of consumers worldwide have made more eco-conscious purchasing decisions, driven by concerns about climate change and waste reduction (Simon-Kucher & Partners, 2021). In Vietnam, sustainability is becoming a key focus, with consumers increasingly prioritizing eco-friendly products. This shift is partly fuelled by government initiatives like Green Growth Project, which seeks to align Vietnam's economic development with environmental sustainability goals (World Bank, 2015). Urban Vietnamese consumers, in particular, are adopting more sustainable habits as they become more aware of global environmental trends (Thong et al, 2017). Vietnam is also committed to addressing climate change by striving to become a net-zero economy by 2050, as outlined in its Nationally Determined Contributions (NDCs). During the COP26 conference, the country revised its NDCs, pledging to reduce emissions by 15.8% by 2030 through domestic efforts and by 43.5% with international assistance. These initiatives, backed by environmental, social, and governance (ESG) policies and regulations, aim to encourage businesses to take a more active role in meeting the nation's ESG goals (United Nations Climate Change, 2021)

Electronic Word-of-Mouth refers to consumer opinions shared via online platforms such as social media, review sites, and blogs. In digital marketing, eWOM is essential because it drives consumer trust, engagement, and decision-making. Unlike traditional advertising, which is company-driven, eWOM comes from consumers and is perceived as more authentic and trustworthy (Cheung & Thadani, 2012). It enables peer-to-peer communication, which has a significant impact on shaping purchasing decisions, especially when it comes to green products.

The purpose of this article is to explore how eWOM can influence sustainable consumption, particularly by promoting eco-friendly behaviors among consumers. It will also examine the opportunities eWOM presents for green brands in Vietnam, where digital platforms and social media have become powerful tools for consumer engagement

2. Method

The article utilizes a combination of synthesis and statistical analysis methods. Data sources are derived from reliable entities such as World Bank, Nielsen surveys, Vietnamese government authorities, Statista, and various academic studies to compile and analyze key findings. This comprehensive approach helps provide an in-depth understanding of how electronic word-of-mouth (eWOM) influences sustainable consumption in Vietnam.

3. Results

3.1. The rise of green consumption in Vietnam

The demand for eco-friendly products in Vietnam has experienced substantial growth in recent years as both consumers and businesses increasingly prioritize sustainability. According to a 2021 Nielsen report, 86% of Vietnamese consumers are willing to pay more for products and services that adhere to sustainable practices, signalling a significant shift toward eco-conscious consumer behavior (Nielsen, 2021). NielsenIQ 2023 survey also revealed significant insights into the growing trend of sustainable consumption in Vietnam. According to the survey, 49% of consumers bring their own bags or use recycled bags while shopping, 47% make deliberate choices to buy only necessary items to reduce waste, and 45% of consumers actively separate recyclables and strive to save electricity; 80% of consumers are concerned about the long-term harmful effects of artificial ingredients and 79% are willing to pay more to buy products that do not contain unwanted ingredients. Ministry of Industry and Trade stated that the demand for green products in Vietnam is growing at an average rate of 15% annually from 2021 to 2023. This reflects the increasing environmental awareness among Vietnamese consumers, with 72% of them willing to pay a premium for eco-friendly products. (Minh Anh, 2023).

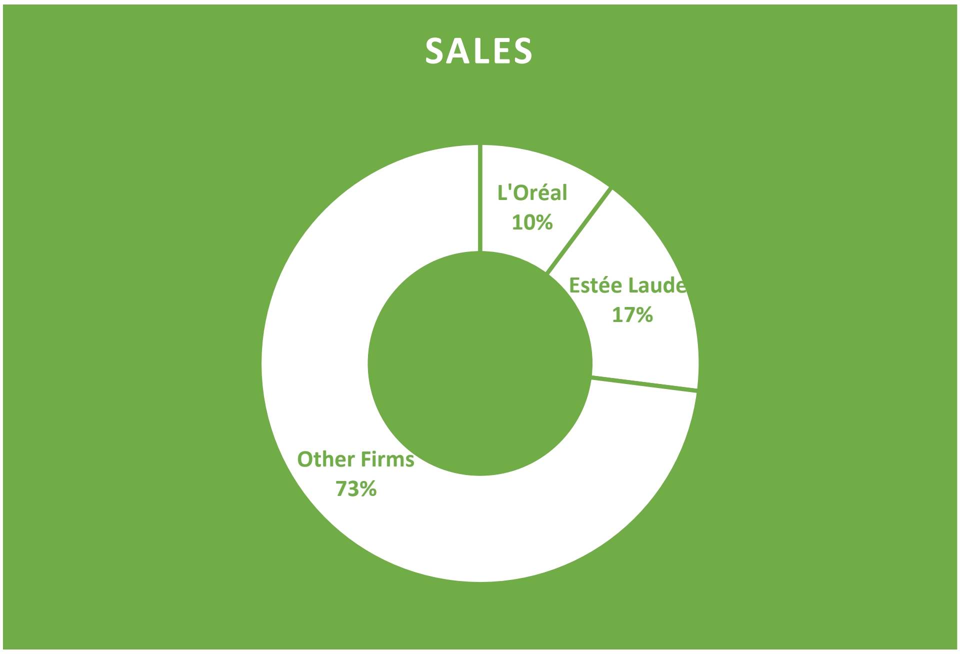

Figure 1: Vietnam Natural Cosmetics Market Share of Value by Companies in 2021 (%)

Source: WM Strategy

This trend is most noticeable in sectors like fashion, cosmetic, and personal care, where consumers are opting for products with environmentally friendly packaging, organic ingredients, or energy-efficient production processes. Additionally, companies are responding by introducing more sustainable product lines, including those made from biodegradable materials and ethically sourced raw ingredients. Based on insights from WM Strategy, the natural cosmetics market in Vietnam was valued at 43.58 million USD in 2017. From 2017 to 2021, the market expanded at a compound annual growth rate (CAGR) of 5.29%, reaching 53.55 million USD. This growth underscores a rising demand for natural and organic products, as Vietnamese consumers increasingly focus on the health benefits and sustainability of the ingredients in their cosmetics.

Several factors are driving this shift towards sustainability. First, heightened environmental awareness among Vietnamese consumers has played a key role. The rise of social media and digital platforms has exposed more people to the global sustainability movement, encouraging them to make more responsible choices. A recent survey conducted by Decision Lab (Thach Huynh, 2024) revealed that younger consumers in Vietnam, particularly millennials and Gen Z, are at the forefront of this change, pushing brands to adopt eco-friendly practices. This shift is also aligned with broader global trends, as consumers worldwide increasingly prioritize the environmental impact of their purchasing decisions.

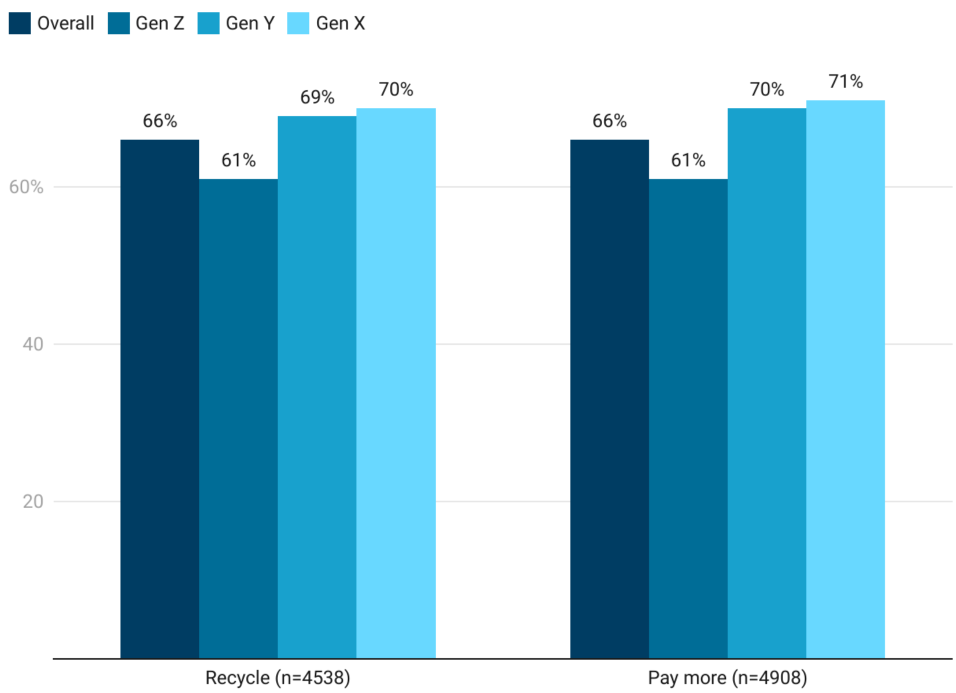

Figure 2: Willingness to recyle/pay more for eco-friendly products-by age groups

Source: Decision Lab

Government initiatives have further accelerated the demand for sustainable products in Vietnam. Vietnamese government's commitment to achieving net-zero emissions by 2050, as pledged during the COP26 conference, has set a clear regulatory direction for businesses to adopt greener practices. National Action Plan on Green Growth and policies promoting the circular economy have also incentivized companies to develop and market eco-friendly products (World Bank, 2015). Additionally, financial incentives, such as tax breaks for businesses that invest in sustainable technologies, have made it easier for companies to integrate sustainability into their operations.

As a result, the convergence of environmental awareness and supportive government policies has created a strong market for sustainable products in Vietnam. Businesses are increasingly recognizing the competitive advantage of offering green products, and consumers are becoming more discerning about the sustainability of the brands they support.

3.2. Challenges in green consumption adoption

Adopting green consumption in Vietnam continues to face multiple challenges, including lack of consumer awareness and education. Despite rising global awareness of sustainability, many Vietnamese consumers are still unfamiliar with eco-friendly products and their benefits. A report by Institute of

Strategy and Policy on Natural Resources and Environment (ISPONRE, 2021) highlighted that only about 40% of Vietnamese consumers recognize eco-labels, significantly limiting the adoption of green products. Without widespread knowledge of the positive environmental impact these products offer, many consumers default to conventional choices. Another key barrier is price sensitivity and the perception that green products are more expensive. According to NielsenIQ (2021), although 72% of consumers in Vietnam express willingness to pay more for eco-friendly products, the higher upfront costs deter widespread adoption, especially among lower-income groups. These consumers often view green products as luxury items, beyond their financial reach. This misconception persists despite evidence that green products, such as energy-efficient appliances, often result in long-term cost savings. In addition, the limited availability and accessibility of affordable green products make it harder for mass adoption. For green consumption to become mainstream in Vietnam, both government and businesses need to address these challenges through targeted consumer education campaigns and financial incentives, such as tax breaks or subsidies for sustainable goods.

3.3. Role of digital platforms in green consumption

Vietnam's digital landscape has seen rapid growth, with social media and e-commerce platforms playing a key role in shaping consumer behavior. As of 2023, there are over 72 million internet users in the country, with 74% of the population actively engaging on social media platforms such as Facebook, Zalo, and Instagram (Statista, 2023). E-commerce has also experienced significant growth, driven by platforms like Shopee, Tiki, and Lazada, which have become central to the purchasing habits of Vietnamese consumers. In 2021, Vietnam's e-commerce market was valued at over $13 billion, with continuous growth expected as more consumers turn to online shopping for convenience (Vietnam E-commerce Association, 2022).

Digital platforms can serve as powerful tools to promote sustainable consumption in Vietnam. Social media enables influencers and eco-conscious brands to educate consumers about the benefits of green products, driving awareness and engagement. For instance, campaigns on Facebook and Instagram highlighting eco-friendly practices and products have helped shift consumer preferences towards sustainability. E-commerce platforms can also support the growth of green consumption by offering dedicated sections for eco-friendly products, allowing consumers to easily identify and purchase sustainable goods. Additionally, platforms like Shopee and Lazada can use data-driven strategies to recommend green products to environmentally conscious consumers, further boosting demand for sustainable goods (Srisathan et al, 2023).

3.4. The power of eWOM in driving green consumption

Electronic word-of-mouth (eWOM) has become a powerful tool in influencing consumer behavior, particularly in the digital age. Online reviews, social media, and influencer marketing significantly shape purchasing decisions. Research suggests that online reviews are a key component of eWOM, with consumers often turning to these reviews for validation before making a purchase. According to Cheung & Thadani (2012), consumers perceive online reviews as more credible than traditional advertising, making them more influential in the decision-making process. Social media platforms, like Facebook and Instagram, have amplified the reach of eWOM by enabling users to share experiences and recommendations with vast networks. Influencer marketing, a form of eWOM, allows trusted individuals with large followings to promote products, further swaying consumer opinions. A study by De Veirman et al. (2017) demonstrated that influencers' perceived credibility and expertise enhance the effectiveness of eWOM in shaping consumer choices, particularly when promoting niche or eco-friendly products.

eWOM plays a critical role in promoting sustainable products, particularly through case studies of successful campaigns. For example, in Vietnam, social media influencers have been key players in promoting eco-friendly practices. A notable case is the collaboration between local influencers and green brands, such as Greenie Vietnam, which markets sustainable and eco-friendly products. Influencers in Vietnam, like Quang Đăng and Giang Ơi, have used platforms such as YouTube and Instagram to advocate for eco-conscious behaviors, helping raise awareness about the environmental impact of consumer choices. These influencers often share personal stories and tips on living sustainably, making green products more relatable and appealing to a broader audience (Hoang et al, 2022).

Several brands have successfully leveraged eWOM campaigns to drive the adoption of green products. For instance, Unilever's "Sustainable Living Plan" utilized eWOM through influencer collaborations to promote sustainable products like their environmentally-friendly home care range. Consumers' online discussions and positive reviews about these products contributed to a significant increase in brand visibility and sales (Ladhari et al., 2020). Such campaigns demonstrate how eWOM can be harnessed to build momentum for eco-friendly products and practices, making it a vital tool for green brands.

Trust and credibility are essential in eWOM communication, especially for green brands that face scrutiny over greenwashing claims. Transparency and authenticity in messaging are crucial in building consumer trust. Consumers are becoming more skeptical of companies' environmental claims, often doubting the authenticity of eco-friendly product labels. This skepticism is particularly evident with the rise of "greenwashing," where companies exaggerate their sustainability efforts to appear environmentally friendly without substantiating their claims (de Freitas Netto et al., 2020).

In this context, eWOM serves as a counterbalance to greenwashing, as consumers trust the experiences and reviews of peers more than corporate marketing. Positive eWOM from authentic sources can reduce consumer skepticism. Studies have shown that when consumers perceive eWOM as genuine and transparent, they are more likely to trust the information and feel confident about their purchase decisions (Filieri et al., 2018). For instance, brands that encourage customers to share honest reviews about their sustainable products on platforms like Facebook or Instagram create a community of trust and transparency. This approach not only builds consumer confidence but also enhances the brand's reputation for integrity in sustainability efforts.

3.5. Opportunities for green brands through eWOM

In order to effectively leverage eWOM, green brands must craft strategies that resonate with eco-conscious consumers. One successful approach is storytelling—brands can share their sustainability journey and highlight their environmental initiatives through compelling narratives. According to Cheung and Thadani (2012), storytelling adds authenticity and emotional connection, which makes eWOM campaigns more relatable. Another effective strategy is encouraging user-generated content (UGC). Green brands can ask customers to share personal experiences or showcase how they use eco-friendly products in daily life. This fosters a sense of community while making the brand's message more credible. Additionally, partnering with influencers who align with eco-conscious values can amplify the message. Influencer marketing plays a crucial role in building trust, with 63% of consumers finding influencer recommendations more authentic than traditional advertising (De Veirman et al., 2017).

To maximize the impact of eWOM, green brands need to target the right demographics. Millennials and Gen Z are more likely to engage with sustainable products and practices, as studies show these groups value eco-friendly consumption (Hoang et al, 2022). Brands should focus on urban populations who are typically more exposed to green products due to better digital access and awareness. eWOM strategies can also be tailored based on regional variations, ensuring that campaigns are relevant to local environmental concerns. For example, urban consumers may be more interested in reducing carbon footprints through eco-friendly transportation, while rural populations might focus on sustainable agriculture practices.

Influencers play a pivotal role in promoting green messages. Collaborating with influencers who are already advocates for sustainability amplifies the message and brings greater reach to green brands. By aligning with influencers who have a dedicated following interested in environmental causes, brands can make their eWOM campaigns more impactful. For example, influencers like Quang Dang in Vietnam use their platforms to promote eco-friendly initiatives, making green products more accessible and relatable to a wider audience (Nguyen & Do, 2020). Partnering with environmental advocates and NGOs can further boost the credibility of green campaigns, as these collaborations lend authority to the brand's eco-friendly claims (Ladhari et al., 2020).

Measuring the effectiveness of eWOM campaigns is essential for green brands. Key performance indicators (KPIs) such as social media engagement, reach, and brand sentiment help gauge the success of these initiatives. Tools like Google Analytics and social media insights can track user interactions and monitor the growth of eWOM campaigns. Additionally, brands can assess the conversion rate—how many potential customers influenced by eWOM actually purchase eco-friendly products (Filieri et al., 2018). Continuous monitoring and adjustments based on feedback ensure that eWOM campaigns remain relevant and impactful in promoting sustainability.

3.6. Challenges of using eWOM for green consumption

One of the primary challenges of using eWOM (electronic word-of-mouth) for promoting green consumption is **combating greenwashing** and addressing **consumer skepticism**. Greenwashing, or the practice of making false or exaggerated environmental claims, can significantly harm a brand's reputation. When consumers discover that a brand’s sustainability claims are misleading, trust erodes, leading to negative eWOM (de Freitas Netto et al, 2020). Green brands must, therefore, ensure transparency and maintain integrity in their eWOM campaigns by backing up environmental claims with verifiable data.

Another challenge is the **digital divide,** particularly in rural areas with limited internet access, which hinders the reach of eWOM campaigns. In Vietnam, while internet penetration is high in urban areas, rural and highland regions still face connectivity issues, limiting the potential reach of green brands (Statista, 2022). To overcome this, brands can adopt strategies such as localizing content for offline channels and collaborating with community leaders to bridge the gap.

Finally, maintaining authenticity in eWOM is crucial. Overly commercialized eWOM campaigns risk appearing insincere, leading to disengagement from consumers. Brands must prioritize genuine user-generated content and transparent influencer partnerships to retain credibility (Cheung & Thadani, 2012).

3.7. Future directions for eWOM and green brands in Vietnam

As eWOM continues to evolve, emerging technologies such as AI-driven reviews, personalization, and blockchain are expected to play pivotal roles in enhancing consumer trust. AI-driven algorithms can filter and highlight relevant customer feedback, making it easier for consumers to engage with credible reviews. Personalization strategies, powered by big data, enable green brands to deliver tailored messages to eco-conscious consumers, increasing the effectiveness of their eWOM campaigns (Huang & Benyoucef, 2013). Additionally, blockchain technology offers transparency by verifying the authenticity of eco-friendly claims, helping green brands combat issues like greenwashing and build greater consumer trust (Hughes et al., 2019).

Sustainable consumption is likely to grow significantly in Vietnam as both consumers and businesses increasingly prioritize eco-conscious behaviors. A report by Switch Asia (2019) highlighted the growing demand for sustainable products in the region, driven by heightened environmental awareness and government policies aimed at promoting green growth. As eWOM continues to shape consumer behavior, it will play a key role in fostering long-term trust and loyalty to green brands. By leveraging eWOM, green brands in Vietnam can position themselves as leaders in sustainable consumption, driving eco-conscious choices and contributing to the country’s broader environmental goals.

4. Conclusion

Electronic word-of-mouth plays a crucial role in influencing sustainable consumption, especially by shaping consumer perceptions and decisions. Green brands in Vietnam can effectively leverage digital platforms such as social media and e-commerce to engage consumers through authentic reviews, influencer partnerships, and storytelling. These strategies create a community of trust and transparency, further driving the adoption of eco-friendly products. The ability to tailor eWOM campaigns for specific demographics and the growing digital landscape in Vietnam present significant opportunities for green brands to expand their reach and impact.

Continuous innovation in eWOM strategies is essential for driving sustainability, especially with emerging technologies like AI, personalization, and blockchain ensuring transparency and authenticity.

In the long run, eWOM will continue to reshape consumer habits by promoting eco-conscious behaviors. As more brands embrace sustainable practices and engage consumers through digital platforms, eWOM will play a key role in fostering environmental change and supporting Vietnam's broader sustainability goals.

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Factors Affecting Tax Administration of E-Commerce Activities - A Literature Review

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Abstract

The purpose of this paper is to provide an overview of research on factors affecting tax administration of e-commerce activities. To obtain the purpose, the team conducted a systematic search on various websites with multiple keywords related to tax administration, e-commerce, and unlimited time and territory. Synthesis and analysis techniques were applied to organize and analyze the identified articles. It showed that tax regulations, taxpayer behavior, the ability to apply information technology, and tax human resources were mentioned among most of the studies. These factors and their influences on the taxation of e-commerce have changed over time. Besides, cross-border e-commerce has been carried out in recent research due to the growth of the global market. Therefore, this study will summarize and review existing academic research comprehensively, thereby providing valuable references for future in-depth studies.

Keyword: *Tax administration, E-commerce, taxation of e-commerce*

1. Introduction

The world has been witnessing the explosion of information technology in most business areas, not only in research, production, and engineering activities, but it is also applied in commercial activities in the market in a variety of forms such as business-to-business (B2B), business-to-consumer (B2C), business-to-government (E2G). Nowadays, buyers and sellers do not necessarily have to meet face-to-face to make transactions, they only need to connect through websites and "virtual" exchanges to be able to meet the consumption needs of each individual and this is the way that e-commerce works. With the emergence of e-commerce, intermediaries will be not only traditional agents and distributors but also digital intermediaries that support online ordering and payment, making the retail market develop in a more efficient direction (Bakos, 2001). E-commerce has its beginnings since the 1960s, but its rapid growth and popularity began in the late 1990s and early 2000s with the explosion of the internet and the advent of the World Wide Web opening up opportunities for e-commerce and Online shopping websites began to appear, such as Amazon (1994) and eBay (1995). Looking back over the past 70 years, the growth of e-commerce has been impressive; global revenue from e-commerce activities reached US$1 trillion in the 1990s and this number has continued to increase, and the value of global e-commerce transactions is estimated to reach US$6.3 trillion according to the Digital Economy 2024 Report, recently released by the United Nations Conference on Trade and Development (UNCTAD), providing a comprehensive view of the development of the global digital economy.

The characteristics of e-commerce along with its outstanding development have caused many difficulties for tax authorities in organizing, managing, and administering tax collection activities in this field. Mas and Varela (2021) pointed out that the difference between traditional tax management and tax management in e-commerce activities comes from the digital nature of e-commerce. Online transactions on digital platforms are carried out by data encryption technology, which helps to transmit information around the world at almost zero cost. However, online sales transactions, online entertainment services registrations, or online advertising campaigns often lack completeness and accuracy of information about the seller, making it difficult to identify and collect the data needed. As well as the continuity and quickness of online transactions, tax authorities also find it hard to monitor and control promptly.

On the other hand, e-commerce is expanding speedily with a variety of business models and a wide range of services such as software, entertainment services, and specifically intangible products and properties which increase the complexity of determining business entities and the value of transactions (Mas and Varela, 2021; OECD, 2015). The participating entities do not need a specific business location, it is possible that only a technological device such as a phone or computer is needed to conduct transactions with a wide range, both domestically and internationally. Besides, an entity can own many online stores on any website, or digital platform, with a vast number of products, and services. While traditional commerce limits payment methods, for e-commerce, controlling cash flow becomes more complicated than ever due to the variety of payment methods such as cash, electronic payment, payment via banking apps, or payment by virtual currency or using virtual banks. For retail activities, e-commerce platforms such as Amazon, Alibaba, Shopee, etc. allow buyers to choose the payment method of cash on delivery (COD), which is considered the most difficult factor for tax authorities in verifying and reviewing revenue from taxpayers. A characteristic factor of e-commerce is cross-border e-commerce, which causes challenges for tax authorities to determine the IP address, permanent establishment of the businesses, and how to levy those entities that are not physically present in a country's territory (Moreno and Brauner, 2019). Otherwise, allocating tax jurisdiction between countries to tax cross-border organizations and how much to tax is still a big issue that is still controversial (Garkushenko and Thiel, 2018).

From the perspective of taxpayer information management, previous studies have shown a marked increase in the number of business households and individuals participating in e-commerce activities. From here, tax collection for these subjects is very complicated due to the diversity of the participating subjects. And at the same time, it is impossible not to mention the lack of awareness in complying with tax obligations of the subjects (Alhasan Usman, 2019). However, there are still cases of revenue loss because of the lack of data or declared information is outdated and no longer valid (Hamdan, 2019).

In terms of coordination between agencies and departments, the connection of information between tax authorities at all levels and related parties, such as e-commerce platforms, has been regulated but is not yet strict and specific, leading to difficulties in building a database for the e-commerce sector (EY, 2017). It can be said that, under the strong impact of objective and subjective factors, tax management for e-commerce activities has been facing multiple obstacles. Problems and conundrums are posed and need to be solved to have a complete apparatus of the tax system, thereby helping tax collection in this field to achieve maximum efficiency.

It is suggested that studying the factors affecting tax administration for e-commerce activities can contribute to enhancing the solutions to remove the tax collection barriers in the digital economy and promote e-commerce development in the future. Based on the proposed research objectives, the research questions that need to be addressed are:

Question 1: What are the selected studies' main research methods and aspects?

Question 2: What is the primary purpose of the reviewed studies?

Question 3: What are the most common factors affecting the tax administration?

Question 4: What are the most common factors affecting the tax administration on e-commerce?

2. Methodology

The research work was implemented and began to systematically search for research documents and dissertations without any limitations in terms of time or geographical boundaries. Realizing the remarkable development of e-commerce nowadays, studies related to the topic have been receiving attention as well as being discussed in economic forums, especially the issue of tax administration for this activity. Therefore, the research group decided to initially conduct a manual screening of reputable and quality sources and then use keywords as a guideline to search for articles that are directly related to the research topic. As a result, in mid-August 2024, the team systematically synthesized papers related to factors affecting tax administration in the field of e-commerce.

First of all, to have a general view of taxation issues for e-commerce activities in countries around the world, we have accessed and searched for current legal requirements in tax administration in this field through the National Public Service Portal, the Ministry of Finance's Electronic Information Portal, and the Ministry of Industry and Trade's e-commerce management system of those countries. We focused on the periods 2010-2018 and 2018 onward, as these saw rapid e-commerce growth worldwide, intensifying challenges for tax authorities in managing tax collection.

The next step is considering the comments and opinions of previous authors on this issue. We searched famous academic journals such as Journal of Economics and Development, Journal of Macroeconomics, Journal of Taxation, Electronic Journal of State Taxation, Journal of Finance and Accounting Research, Journal of Forestry Science and Technology, Journal of Finance, Journal of Science and Politics, Journal of Finance and Accounting Research within the scope and time scale from 2000-2024. Additionally, we approached references to tax services provided by companies such as Big4 for businesses operating in e-commerce areas. It is also essential to look up research documents that have been published by major organizations in the world such as OECD, IMF, and World Bank. Thus, it can be said that through the steps given, a comprehensive picture has been drawn for the parallel relationship between the development of e-commerce activities and the improvement in tax administration for this sector.

In addition to domestically published journals, we applied Connected Papers as a tool to identify documents that are related to each other and related to the research topic through searching for keywords on the toolbar, keywords that can be mentioned as "e-commerce", "tax administration", "tax administration in e-commerce", etc. Foreign articles and journals associated with research topics are also searched through websites that provide academic documents such as Science Direct, Springer, Google Scholar, and Researchgate. Moreover, the electronic libraries of domestic and foreign universities such as Harvard University, Addis Ababa University, Southern University, National Economics University, etc. are also considered quality reference sources for our study. As mentioned, our search will not only stop at reviewing studies with the keywords “tax administration in e-commerce", but also search for articles with the keywords “e-commerce” and "tax administration” and these documents are found in the references section of articles related to the tax administration in e-commerce. The characteristics of tax administration in general and tax administration for e-commerce activities must be different owing to the complex nature and continuous innovation of the e-commerce sector. Nevertheless, there will still be similarities in the core points of these two tasks because the basis of tax administration in e-commerce is the general tax administration process. Consequently, we have adopted the Snowball method to select documents as conveniently and quickly as possible.

To select quality documents, the authors also proposed selective evaluation criteria for the thesis and article system. Firstly, documents, theses, dissertations, and articles should be published from 1990 to 2024. However, we focused on the period from 2010 to 2018 and from 2018 to the present because these are periods with strong development of e-commerce. Secondly, we will not delve into issues related only to the transaction process in e-commerce but will focus deeply on research on tax administration in this field. Lastly, the selected research has been published in reputable media sources and classified as research, analysis, magazines, articles, seminars, books, etc. As a result of manual screening, we were able to narrow the scope of research documents from 978 to 436. Along with that, we eliminated research publications that were not related to the group research’s questions. Categorizing articles by groups based on the criteria of keywords shown in Table 1 is the next step. We continued to select articles by reviewing and evaluating in detail the title, keywords, and abstract of the article to see if it directly addressed the research problem. Furthermore, the identified articles must have full citations of references and sources to ensure the reliability of the publication. Combining these designed steps to create a detailed selection process, we have reached 236 research articles. It is inevitable that the case of articles being duplicated. The next stage was conducted to carefully examine each issue mentioned in the documents and remove duplicate articles. The final dataset was thus limited to 128 articles with a total of 19 articles that were inaccessible or no longer available. Eventually, the results of the dataset carefully selected to serve the research topic are a total of 108 papers (Table 1).

Table 1: Sample of articles

Keywords	Articles accessed
Tax administration	56
E-commerce theory	21
Factor influencing tax administration	17
Efficiency of tax administration	14
Challenges of tax administration	24
Tax administration on e-commerce	49
Factor influencing tax administration on e-commerce	21
Efficiency of tax administration on e-commerce	11
Challenges of tax administration on e-commerce	23
Total articles	236
Overlapping articles	109
Remaining articles	127
Non-available articles	19
Total articles accessed	**108**

Source: Authors

3. Results

3.1. Overview of e-commerce research

E-commerce is a widely popular business activity in the global economy today due to the application of advanced technology in its operations (Taher, 2021). To generalize the main research on e-commerce, it is essential to mention the book "Economics of Electronic Commerce" by Soon-yong Choi et al. (1997), along with the publication "Electronic Commerce – A Manager's Guide" published the same year by Ravi Kalakota and Andre B. Whinston (1997). These works are highly regarded for providing an overview of e-commerce, especially emphasizing the role of information technology as a driving force for the field's robust growth. In addition, based on and synthesizing previous studies on e-commerce, many books have also been published to support scholars' research. Notably, "Basic E-commerce Textbook" (Tran Van Hoe, 2008) of National Economics University, "E-Commerce: Concepts, Principles, and Application" (Zheng Qin et al., 2022), "E-Commerce 2021-2022: Business, Technology and Society, Global Edition" (Kenneth et al., 2021). Globally, there are numerous other comprehensive studies on e-commerce, such as "Electronic Commerce: Structure and Issue" (Vladimir Zwass, 1996), "Handbook on Electronic Commerce" (Whinston et al., 2000), "Electronic Commerce: Definition, Theory and Context" (Rolf T. Wigand, 1997), and "Electronic Commerce" (Perry and Schneider, 2001). Articles in journals also serve as reliable sources for this study, and we have identified several prominent articles that provide a multi-dimensional view of the development of e-commerce. These include "Consumer Marketing Strategy and E-Commerce in the Last Decade: A Literature Review" (Rosário, Albérico and Ricardo Raimundo, 2021), "E-Commerce and Consumer Protection in India: The Emerging Trend" (Chawla and Kumar, 2021), "Challenges and research opportunities in eCommerce search and recommendations" (Tsagkias et al., 2020), and "Cyber-physical e-commerce logistics system: An implementation case in Hong Kong" (Kong et al., 2020).

More detailed and specific studies, such as Yakos (2002), show that e-commerce has a profound impact on the retail market, particularly in aspects such as costs, pricing, competition, and the role of intermediaries. Conducting business through e-commerce significantly reduces search costs for buyers (e.g. travel, information search) and sellers (e.g. market research, advertising, and information delivery costs). This enhances price competition in the digital marketplace, compelling sellers to improve the quality of services and products and ensure customer loyalty. In line with this view, Le Thi Thuy Linh (2022) suggests focusing on building the e-commerce infrastructure and promoting its development, emphasizing the cost and time-saving benefits of the transaction process. Additionally, Attar (2022) asserts that e-commerce platforms have been widely used over the past few decades because they facilitate business transactions between suppliers, businesses, and customers on the Internet, significantly reducing related costs and time while increasing transaction efficiency. Emphasizing the technological factor, Hamdan (2019) indicated that applying technology in e-commerce improves the information linkage between managers, government regulatory agencies, customers, employees, and the public. Similarly, Burt and Sparks (2003) emphasized that technological innovation allows the restructuring of business relationships and distribution channels in e-commerce. In connection with tax issues, the development of e-commerce poses challenges for tax collection in this area (Mwencha, 2019). In addition, the authors highlight the complexity and widespread nature of e-commerce, raising questions about how regulations, laws, and policies should be implemented to maximize tax collection efficiency from this activity. Thus, it can be said that e-commerce has been discussed extensively worldwide and domestically, with growing attention to tax administration in this field.

3.2. Overview of factors affecting tax administration

The group has compiled some main factors affecting tax administration in general and tax administration in e-commerce in particular, such as legal regulations and policies, tax socialization activities, human resources, cross-border e-commerce, and technological infrastructure (Table 2). These factors will be discussed in detail below:

3.2.1 Research on factors affecting tax administration

Globally, the concept and research on tax administration have been examined from various angles. Numerous factors impact tax administration, including political revolutions, bureaucratization within state structures, and management styles that significantly affect tax administration performance and staff (Vahedi, 2014; Kiser et al., 2001; Antonakas et al., 2013). Most previous studies have focused on systematizing the theoretical foundations and structures of tax administration and analyzing the effectiveness of tax management through factors such as tax systems, tax laws, online service implementation, and technological restructuring.

Research by Tanzi and Pellechio (1995), Drobyshevskaya et al. (2020), Rahayu and Lingga (2009), Athanasios et al. (2022), Akitoby (2018), Salawu (2023) emphasized the importance of establishing an efficient tax administration system. The mechanisms and models of tax administration play a crucial role in enhancing the oversight and management capacity of tax authorities. In Nigeria, Shagari's (2014) study further highlighted the significance of the autonomy of the State Board of Internal Revenue (SBIR). Beyond this, Olaoye Clement Olatunji and Kehinde Busayo Ayodele (2017) identified additional key factors such as the government, the organizational structure of tax agencies, taxpayers, and technological advancements. The research by Zulma and Hizazi (2020) also stresses the importance of applying technological innovation and Big Data tax management, as well as improving the quality of human resources in the tax sector and revising tax laws. Research by Alhasan Usman and Alhasan Usman (2019) published in the IOSR Journal of Humanities and Social Science, also identifies the significant influence of tax officials' competence on the dependent variable, with the highest standardized Beta coefficient. The benefit of raising taxpayer awareness is that it enables tax authorities to promptly address and resolve issues regarding taxpayers' understanding of tax regulations (Seralurin et al., 2021). Additionally, aside from the internal factors of the tax authority, external factors such as autonomy, transparency, accountability, and motivation also play an important role in the overall effectiveness of tax management (Aziz and Harethi, 2018).

Research by Shagari (2014), Olatunji and Ayodele (2017), and Rahayu and Lingga (2009) has explored the key determinants of tax administration effectiveness by measuring factors such as the use of information and communication technology (ICT), audit practices, and taxpayers' perception of corruption. Qualitative findings indicate that ICT usage is a determining factor for effective tax administration, enabling efficient tax collection from taxpayers across various economic sectors. Pogorletskiy and Bashkirova (2015) conducted research on tax administration development in the Russian Federation, focusing on reducing administrative pressure on taxpayers and enhancing the role of the Federal Tax Service. In Russia, digital infrastructure and online services have become simple and convenient tools in the relationship between tax authorities and taxpayers, which reduces the management burden and improves the quality of tax advisory services. Indeed, tax administration systems have become increasingly modernized with technological advancements, offering services such as electronic registration, electronic filing, electronic payment, and electronic invoicing (Rahayu and Lingga, 2009). Sitorus' (2018) research in Jakarta, Indonesia, echoes this sentiment, arguing that maximizing ICT usage will support transparent and open tax administration, minimizing corruption, collusion, and even the abuse of power. The application of ICT is expected to strengthen control mechanisms in tax officials' management behavior and improve their execution of duties and governance.

Additionally, Rani et al. (2011) argue that tax policies and tax administration influence each other. Effective tax administration is considered a prerequisite for the successful implementation of tax policies. Moreover, tax professionals play a key role in enforcing national income tax laws. Tanzi and Pellechio (1995) also studied the reasons behind poor tax administration and identified essential factors for improving tax administration. Their research pointed out that complex and opaque tax laws make it difficult for taxpayers to understand, leading to ineffective tax management. As a tool for tax administration, government-issued policies represent a system of viewpoints and strategies chosen and explained by the government, and they are considered to have both direct and indirect impacts on tax administration (Thomas Dye, 1972). Faria and Yucelik (1995) illustrated that the design of tax policies needs to pay attention to administrative constraints in tax administration, thereby limiting ineffective tax administration that weakens tax policies.

Moges (2018) conducted research in Ethiopia and emphasized the need to simplify legal documents and tax regulations so that not only state regulatory agencies but also taxpayers can easily comply, thereby enhancing tax collection efficiency for the national budget and ensuring sustainable economic development. Agreeing with this view, Datrini et al. (2024) also indicated that understanding tax regulations, whether through formal or non-formal education, is one of the factors that positively influence taxpayer compliance. Conversely, Gale (2003) demonstrated that while most people agree that taxes should be simple and perfectly enforceable, no tax system easily meets these standards. Essentially, despite good technical implementation, simplifying the tax system remains a major challenge.

3.2.2. Research on factors affecting tax administration of e-commerce activities.

Since the end of the 19th century, Prasad Bingi et al. (2000) affirmed that the development of e-commerce began to create many new formulas for businesses and management agencies on all other aspects of economic, technical, social, and especially tax management in e-commerce. Further research by Subhajit Basu (2008) demonstrated that owing to the non-physical spatial nature of the Internet, e-commerce activities complicate traditional concepts related to identification of production locations, point of sale, product classification, income classification, and the government's taxation authority. Meyer Drucker et al. (2012) pointed out that the large number of individuals and businesses transacting via e-commerce puts heavy pressure on the tax administration system, requiring coherent regulations and tax regimes that are more suitable for each country.

For e-commerce activities, OECD has conducted some research that considered a theoretical framework for countries to use as a basis and make amendments to the existing tax management works for the e-commerce sector. In 2001, OECD published the study through a six-chapter book titled "Taxation and Electronic Commerce - implementing the Ottawa taxation framework conditions", which outlines the context of the development of e-commerce posing major challenges to the tax management system and the application of the Taxation Framework Conditions adopted in October 1998 in Ottawa. There are 4 basic principles established: neutrality, efficiency, certainty and simplicity, and flexibility. In particular, OECD emphasized the neutrality of applying existing taxes to e-commerce instead of creating a new tax law, which means there will be no difference between the commercial tax law and e-commerce tax law. Hamdan's (2019) study on the impact of e-commerce on tax administration in China also emphasized the importance of flexibility in using the principle of equality, thereby ensuring that e-commerce tax policies are consistent with international policies, avoiding double taxation, and creating a fair and stable environment for businesses.

Lipka (2022) also affirmed that the rapid development of e-commerce has brought many challenges to the regulatory legal system. Specifically, traditional trade and e-commerce have different characteristics, but they are comparable in tax regulations. In the General Framework for Taxation

(1998), the OECD emphasized the neutral principle of applying common tax laws to traditional commerce and e-commerce (OECD, 2001). As a result, a dilemma is posed to countries under the strong development along with the specific nature of e-commerce, in the long run, traditional commercial tax laws can no longer meet the innovation in e-commerce (Yarong et al., 2012). This creates loopholes and taxpayers can easily evade taxes, causing tax revenue loss for the state budget. On the other hand, each country has its own legal and institutional framework for tax laws, but e-commerce is cross-border in nature and the lack of unified regulations and frameworks between countries will lead to taxpayers being subject to double taxation (Effiong, 2019). The establishment of the international tax regime has been studied since the 1920s (Rifat Azam, 2011). In general, the "generality" of tax law for e-commerce activities and the contents of legal regulations have not been completed, which has caused difficulties in tax administration (Le Thi Thuy Linh, 2018). In order to aim for and achieve efficiency in the management and collection of taxes from e-commerce, it is essential to complete and specify the law and this is also a proposal by researchers.

Studies by Cockfield (2019), OECD (2020), and Tran Trung Kien (2022) have affirmed the need for a separate legal document that stipulates tax obligations for e-commerce so that taxpayers can fully and proactively comply with them. Recent studies have also discussed recent tax policies and the need for a separate legal framework to manage taxes in the digital economy (Bunn et al., 2020; Olbert et al., 2020). Nevertheless, Doe et al. (2020) argued that creating a separate legal framework is very complicated and requires international cooperation to address the issues of tax evasion and profit shifting. In addition, the tax authority has not allocated reasonable resources, the management skills of tax officials are still limited, and tax officials have not been trained in specialized skills and expertise to manage taxes in the e-commerce sector, resulting in a significant risk of revenue loss in e-commerce.

Simultaneously, research by Scarcella (2020) showed that the taxpayer compliance factor plays a decisive role in improving the efficiency of e-commerce tax management. Moreover, Alm (2012) showed that tax compliance plays an important role in improving the efficiency of e-commerce tax administration. This study collected data from 34 countries, including Albania, Germany, and South Korea, over 8 years, finding that higher tax morale among firms leads to better tax compliance. Key factors influencing compliance included corruption, tax system complexity, and firm ownership type (Kirchler et al., 2008; Alm et al., 2012).

For e-commerce in particular and other fields in general, to promote effective tax administration, not only subjective factors of professionalism and quality from the tax authorities but also the factors of awareness and behavior of taxpayers also have a direct impact on tax administration. The awareness and understanding of each individual vary at different levels, but intending to improve people's self-awareness and tax compliance, it is necessary to strengthen efforts in tax propaganda and socialization (Guan Yue et al., 2019; Khamis and Mastor, 2021). The factor of community propaganda also has a positive impact on the quality of tax management (Sania and Yudianto., 2018). From the same perspective, the research papers of (Wu Yan et al., 2010) analyzed the propaganda activities to support taxpayers to dominate tax administration in e-commerce, also examined the impact and assessed the positive impact of tax socialization on tax control.

Research by Joseph (2019) showed that e-commerce activities taking place in cyberspace are increasingly complicated, requiring tax officials to have in-depth knowledge and supporting tools to be able to trace transactions to serve inspections and checks. However, the number of tax officials who meet these conditions is currently not large. On this basis, the research of Giang Thi Thu Huyen (2023), Nguyen Pham Anh Khoa (2023) has agreed that it is necessary to take advantage of technology applications (management software, electronic tax data,...) to promptly detect violations and improve objectivity in handling violations. Several countries in the Asia-Pacific area have also begun to carry out modernization campaigns in management, such as the application of Big Data, biometric identification, the use of blockchain, chatbots, and automating processes with artificial intelligence (AI) (Hassan, Mashiyat, and Tasnia, 2022). As of 2020, up to 15 countries have used chatbot virtual assistants to support consulting and answering customers such as Australia (ATO's virtual assistant Alex), Mongolia, Singapore, Tajikistan, etc., while China, Vietnam, and Indonesia are developing application software (Asian Development Bank, 2022). Moreover, up to six countries have implemented the application of robotic process automation (RPA), including Australia, India, Japan, China, Singapore, and Georgia (Asian Development Bank, 2022). Although AI models still need further research, in general, the management system is increasingly effective, meeting the needs of countries.

Many studies have also shown that the increase in online transactions with foreign suppliers has created many challenges for tax administration related to cross-border e-commerce. The difference between e-commerce and traditional commerce has made it difficult to determine the tax base and source of income. The issue of identifying permanent establishments, controlling transactions, and controlling cash flow when there are too many payment methods is a big gap in the principles of taxation (Agrawal and Fox, 2017). Sharing the same view, Gałuszka (2013), Mwencha (2019), Bowen et al (2019), Liu (2020), and Abdulrahman (2022) also pointed out that those difficulties come from the nature of e-commerce such as diversification of business forms, accessibility, convenience for people to buy and sell at any time without being limited by space or location. For that reason, the management system becomes complicated because there are too many participants, coming from many countries, creating a large amount of data that is difficult for tax authorities to control. The increase in cross-border transactions will impose greater and greater requirements on tax administration, especially for regulatory agencies that previously only related to traditional domestic trade. On that basis, Wulandari et al. (2023) the research also emphasized the management, inspection, and exchange of taxpayer information between countries is extremely important.

4. Research gaps and Future research proposals

E-commerce has undergone several stages of development, starting from retail websites in the 1990s, diversifying into various online business models in the 2000s, and continuing to thrive with the integration of advanced technologies to meet global consumer demand. Research on tax administration in e-commerce began in the 20th century. In 2001, the OECD published a series titled "Taxation and Electronic Commerce – Implementing the Ottawa Taxation Framework Conditions," which provided theoretical frameworks for countries to learn from and adapt tax administration practices in the e-commerce sector. However, each country has unique economic, cultural, and legal contexts, meaning that the implementation and enforcement of e-commerce tax administration policies differ from country to country.

From 2000 to 2010, e-commerce platforms and websites had just begun to emerge in some countries, and tax administration in e-commerce was still primarily focusing on traditional business models, with no specific studies on e-commerce taxation. Studies by Tanzi and Pellechio (1995), Rahayu and Lingga (2009), and Shagari (2014) focused primarily on systematizing the theoretical foundations of tax administration in general, tax management mechanisms and models, and learning from foreign tax administration systems. Therefore, studies specifically addressing the influencing factors and determining the level of influence of tax management in e-commerce during this period were limited. Most studies emphasized that the quality, competence of tax officials, and the structure of tax management are the key factors influencing tax administration. In contrast, during this period, some studies in developed countries showed that the application of information technology increased the level of tax administration efficiency. Burt and Spark's (2003) research on retail markets in the United States demonstrated that the application of information technology positively influenced tax administration, enhancing tax authorities' control mechanisms and the behavior of tax officials. Similarly, research by Rahayu and Lingga (2009) showed that information technology support allows tax authorities to access transaction information through online databases, accelerating tax collection and tax administration for e-commerce activities.

From 2010 to 2018, Studies by Herryanto and Toly (2013), Zhu Pang (2017), and Hartanto (2020) demonstrated that, in addition to the quality of tax officials, other important factors affecting tax administration in e-commerce include legal policies, challenges in cross-border e-commerce, and the application of technology to monitor and oversee transactions. While previous studies have mainly focused on the theoretical foundations of tax administration, these studies have addressed tax administration in e-commerce, analyzed the current situation, and proposed solutions to improve the quality of tax administration. However, most studies only provide a brief overview and do not conduct in-depth, comprehensive research on the influencing factors. Notably, the level of impact and the nature of these factors have also changed over time. Although there have been improvements and updates in tax collection and administration for this area, there are still many challenges, requiring further research and additional regulations to improve management efficiency.

Since the COVID-19 pandemic, e-commerce has reached new heights, necessitating the application of new technologies alongside updates to legal policies. Factors such as the development of technological infrastructure, such as electronic tax administration systems, data analysis tools, and invoice management software, have become crucial in handling large transaction volumes and improving tax administration efficiency. Countries worldwide, such as China, Australia, Indonesia, Mongolia, Singapore, and Tajikistan, have begun implementing big data, chatbots, and artificial intelligence (AI) in their tax administration systems. Moreover, many foreign studies by Jolanta (2013), Bowen et al (2019), Liu (2020), and Abdulrahman (2022) express the view that issues related to jurisdiction, tax authority, permanent establishment, and the scope of tax collection in cross-border e-commerce remain significant. Due to the pervasive and global nature of e-commerce, cross-border transactions have had increasingly complex and significant impacts on tax administration.

Thus, we hope that future research teams will expand the scope of research by conducting surveys and studies in multiple countries with different cultures and at different times. This would provide deeper insights into the differences and commonalities in factors affecting e-commerce tax administration and gather more valuable and useful information relevant to a broader context. Additionally, identifying and analyzing new influencing factors is also crucial.

5. Conclusion

The advent of information technology has created new trends in business, particularly in e-commerce. This sector brings significant revenue to the state budget; however, difficulties remain in tax administration, particularly in managing cross-border e-commerce transactions, leading to substantial tax revenue losses. Increasing numbers of individuals engage in business activities, live streaming sales on social media platforms, or providing online services due to the outstanding advantages of e-commerce. Therefore, it is undeniable that e-commerce is growing and playing an increasingly important role in contributing to state budget revenues. As a result, the study of factors affecting tax administration in e-commerce activities is gaining more attention from the public, especially from taxpayers and tax authorities. This interest stems from the rapid growth of e-commerce and the need for tax management to ensure fairness in tax collection, making sure that all income sources are subject to taxation in accordance with the law, and promoting transparency in e-commerce business activities.

Through the process of analyzing and collecting data from relevant studies, and by examining the factors affecting tax administration in e-commerce from existing research, we ensured the accuracy and reliability of the information. Based on this, the research team has identified and analyzed the factors influencing tax administration in e-commerce. The team has selectively reviewed government systems and utilized various search tools with different keywords related to tax administration, e-commerce, and tax management in e-commerce. The research was not limited by space or geographic boundaries. As a result, we have gained a comprehensive overview of previous research, foundational theories, and research models related to tax administration and factors influencing tax administration in e-commerce. We aim to provide research findings and discussions that are professional and reliable, serving as useful reference material for other related research topics.

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Digital Transformation in Tourism in Yen Bai province, Vietnam: Practices, Problems and Solutions

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Abstract

Yen Bai province, endowed with distinctive agricultural and forestry resources, has made notable progress in rural tourism development and digital transformation. Significant advancements in digital transformation are evident, with Yen Bai ranking 15th in the Digital Transformation Index (DTI) and 7th in the digital economy sector. Despite these achievements, several limitations persist. Local accommodations on online booking platforms are minimal, and tourism communication effectiveness is low. Furthermore, a shortage of skilled human resources in the tourism and digital transformation sectors hampers progress. The study examines the current state of digital transformation in Yen Bai's tourism sector, identifying challenges and proposing solutions to overcome these barriers. By analyzing secondary data, including stakeholder interviews, the research provides insights and offers recommendations to ensure sustainable tourism development in Yen Bai. The study proposes a smart tourism ecosystem model integrating digital technology, emphasizing the Internet of Things (IoT), Big Data, Artificial Intelligence (AI), virtual reality (VR), Augmented Reality (AR), and Blockchain. This model aims to enhance tourist experiences, optimize business operations, and improve management oversight. Addressing these challenges through targeted strategies and collaborations will be crucial for maximizing Yen Bai's digital transformation potential in rural tourism.

Keywords: *Digital transformation, digital transformation in tourism, community-based tourism, Yen Bai province, Vietnam*

1. Introduction

Digital transformation (DT) has emerged as a critical driver of competitiveness across various sectors, including tourism (Buhalis & Amaranggana, 2015). Integrating digital technologies revolutionizes how destinations are marketed, managed, and experienced. In developing regions, particularly those with rich cultural and natural assets, DT offers a unique opportunity to enhance tourism experiences, increase accessibility, and drive significant economic growth. This potential for economic development should make the audience feel the potential benefits of these changes. DT has emerged as a pivotal force reshaping industries, including tourism, in the contemporary global economy (Vial, 2019). DT refers to integrating digital technologies into various business operations, profoundly impacting how organizations deliver value to customers and interact with stakeholders. This transformation has unlocked new possibilities for enhancing customer experiences, improving operational efficiency, and expanding market reach for the tourism sector. The rapid adoption of big data, artificial intelligence (AI) (Xiang & Fesenmaier, 2017), the Internet of Things (IoT), and mobile applications has enabled tourism destinations to offer more personalized, seamless, and efficient services (Gretzel et al., 2015). However, the DT journey is fraught with challenges, particularly in regions where infrastructure, skills, and resources are still developing (Elia et al., 2020).

Over the last five years, global revenue from travel apps has tripled, surpassing US$1.2 billion by 2023 (Statista Research Department, 2024b). Statista Market Insights estimates show that the United States alone accounts for more than 40 percent of the total value, ahead of China, the second-largest market based on revenue for travel apps worldwide. Travelers are also starting to use digital technologies to plan and choose their destinations. According to a global report by Statista, as of October 2023, 20% of respondents used AI chatbots to plan their trips (Statista Research Department, 2024a). In Vietnam, according to Mordor Intelligence, the online travel market in 2024 will be worth 9.2 billion USD.

In the overall tourism industry trend, the global CBT market was valued at $575.9 billion in 2022 and is expected to reach $2136.8 billion by 2032. Asia-Pacific is the largest and fastest-growing region in the CBT market and is forecast to lead the global market from 2023 – 2032 (Allied Market Research, 2023). According to statistics from the Viet Nam National Authority of Tourism in Vietnam, by 2020, the country will have about 300 villages, hamlets, and residential groups in the community tourism (Vietnamnet. vn, 2024).

Yen Bai Province, located in the Northern Midlands and Mountains region of Vietnam, is a prime example of such a destination. Known for its breathtaking landscapes, such as the terraced rice fields of Mu Cang Chai, and its rich cultural heritage, Yen Bai has the potential to become a significant tourist destination both domestically and internationally. However, the province must navigate its tourism sector's DT process to realize this potential. This process involves adopting new technologies, transforming business models, and overcoming inherent challenges such as limited digital infrastructure, skill gaps, and the need for coherent strategies. The success of digital initiatives depends not only on the availability of technology but also on the ability of stakeholders—from government bodies and local businesses to the tourism workforce and visitors.

Despite its significance, DT in Yen Bai's tourism sector still needs more research. Existing studies on DT in tourism have predominantly focused on more developed regions, leaving a knowledge gap concerning less urbanized areas like Yen Bai. Addressing this gap is essential for understanding the unique challenges and opportunities of Yen Bai. This study aims to evaluate the current state of DT in Yen Bai Province's tourism sector, identifying the practices implemented, the problems encountered, and the potential solutions to overcome these challenges. By doing so, the research aims to contribute to the research on DT in tourism, offering insights that can be applied not only in Yen Bai but also in similar contexts within Vietnam and other developing regions. The research seeks to answer the following questions: What are the current DT practices in Yen Bai's tourism sector? What problems are hindering the effective implementation of digital technologies in the industry? What solutions can be proposed to facilitate the successful DT of tourism in Yen Bai?

2. Literature review

DT has emerged as a critical driver of competitiveness across various sectors, including tourism. Integrating digital technologies revolutionizes how destinations are marketed, managed, and experienced (Hausberg et al., 2019). In developing regions, particularly those with rich cultural and natural assets, DT offers a unique opportunity to enhance tourism experiences, increase accessibility, and drive economic growth. DT has emerged as a pivotal force reshaping industries, including tourism, in the contemporary global economy (Vial, 2019). DT refers to integrating digital technologies into various business operations, profoundly impacting how organizations deliver value to customers and interact with stakeholders. This transformation has unlocked new possibilities for enhancing customer experiences, improving operational efficiency, and expanding market reach for the tourism sector. The rapid adoption of big data, artificial intelligence (AI), the Internet of Things (IoT), and mobile applications has enabled tourism destinations to offer more personalized, seamless, and efficient services. However, the DT journey is fraught with challenges, particularly in regions where infrastructure, skills, and resources are still developing.

DT has become crucial in modernizing various sectors, including tourism. DT in tourism has become a global trend, dramatically changing how tourism businesses and destinations interact with customers. The development of digital technology, from AI and big data to the IoT, has enabled tourism organizations to optimize processes, improve customer experience, and expand marketing opportunities. DT helps increase operational efficiency and allows tourists to personalize their experiences through digital platforms (Buhalis & Amaranggana, 2015). Furthermore, the application of digital technology in the tourism industry also contributes significantly to minimizing environmental impacts through intelligent management and efficient use of resources (Gretzel et al., 2015). This is especially important in the tourism industry, which faces global sustainable development challenges. The concept of smart tourism, which integrates digital technologies to enhance tourism experiences, has gained traction globally. In developing countries like Vietnam, DT can significantly unlock the potential of CBT. According to Buhalis and Amaranggana, intelligent tourism destinations leverage digital tools to offer personalized services, improve operational efficiency, and expand market reach (Buhalis & Amaranggana, 2015). However, the success of such initiatives depends on overcoming challenges related to infrastructure, digital literacy, and resource allocation (Vial, 2019) (Elia et al., 2020).

In the context of CBT, community involvement is essential for sustainable tourism development. Lee and Jan emphasize that local communities must actively participate in tourism planning to ensure that benefits are equally distributed and cultural and environmental resources are preserved (Lee & Jan, 2019). CBT is based on the concept of community development in which local people participate in tourism development planning regarding resource conservation, socio-economic development, and ownership. The community can be divided into three dimensions. First, participation, initiated from partial or full ownership, is a critical element of operating this type of tourism. Second, power and control are aspects of the relationship between local community factors, historical and social context, and CBT operators. Third, tourism outcomes and quality must support autonomy, equity, sustainability, and independence in the community operations (Mayaka et al., 2019). Despite the potential benefits, the digital divide remains a significant barrier in less urbanized areas. As Gretzel noted, the disparity in access to digital tools between urban and rural areas can exacerbate existing inequalities (Gretzel et al., 2015). Therefore, considering each region's unique challenges and opportunities, an approach to DT in tourism is required.

3. Methodology

This study uses qualitative research techniques to address the research questions. The methodology is designed to provide a comprehensive understanding of DT in the Yen Bai tourism industry, capturing the topic's breadth and depth. The study is divided into three main stages: (1) literature review, (2) data collection, and (3) data analysis.

The literature review, a meticulous process, serves as a robust foundation for the study, providing context and identifying key concepts and theories related to DT in tourism. The documents used in the review are taken from reputable sources such as Scopus, Springer, etc. Reading, classifying, and comparing documents helps the authors draw out theories and concepts related to DT in tourism, ensuring a comprehensive understanding for the audience.

The data collection stage includes primary and secondary data collection. Secondary data is collected from official reports, academic publications, and online sources. Information related to the tourism context and digital transformation in tourism in Yen Bai is mainly collected from official online information channels such as Yen Bai electronic newspaper, Yen Bai provincial electronic information portal, etc. Primary data is collected through visual observation and expert interviews. Visual observation is applied when evaluating online tourism information channels of Yen Bai province. In addition, the research team interviewed 05 experts through direct phone calls to obtain information and assess the actual situation. The list of interviewed experts includes

1. Mr. Nguyen Hoang Long - Deputy Director of the Department of Culture, Sports and Tourism of Yen Bai province;
2. Ms. Hoang Thi Van Mai - Deputy Chief of Office of the Department of Culture, Sports and Tourism of Yen Bai province;
3. Mr. Pham Viet Phuong - Director of the Center for Monument Management and Tourism Development of the Department of Culture, Sports and Tourism of Yen Bai province;
4. Ms. Nguyen Thi Tot - Department of Culture and Information of Yen Binh district - Department of Culture, Sports and Tourism of Yen Bai province;
5. Mr. Giang A De - Homestay Hello Mu Cang Chai, La Pan Tan commune, Mu Cang Chai district, Yen Bai province.

Finally, the data analysis phase integrates qualitative data to create insights and propose solutions. The collected data will be classified and used comparative and inductive methods to analyze and draw conclusions. This rigorous approach to data analysis ensures the reliability of the study's findings, providing the audience with confidence in the research outcomes.

4. Results and Discussion

4.1. Current state of DT in tourism in Yen Bai

4.1.1. Government management and policies

In recent years, Yen Bai province has coordinated with agencies, departments, and telecommunications corporations to promote DT in CBT activities locally. The approval of Decision No. 749/QD-TTg dated June 3, 2020, by the Prime Minister, approving the "National DT Program to 2025, with a vision to 2030," has emphasized DT in many fields, including tourism, agriculture, natural resources, and the environment. The decision is the foundation for Yen Bai's strategic efforts in integrating digital technology into its tourism industry. In addition, the implementation of Decision No. 922/QD-TTg dated August 2, 2022, on RT development in new rural construction has aimed to promote the development of rural tourism RT associated with the advantages of agriculture, craft villages, culture, and ecological environment in the locality. The provincial government has also actively linked with national strategies through many decrees and resolutions, such as Decision No. 147/2020/NQ-TTg and Decision No. 263/QD-TTg, which set out the framework for tourism development and the national target program on new rural construction from 2021 to 2025. Implementing these directives, the Yen Bai Provincial People's Council issued Resolution No. 14/2017/NQ-HDND on April 10, 2017, to encourage investment in high-tech industrial services and agricultural tourism. Resolution No. 51, dated July 22, 2021, followed this, clearly stating the province's DT goals from 2021 to 2025. Furthermore, according Mr. Nguyen Hoang Long - Deputy Director of the Department of Culture, Sports and Tourism of Yen Bai Province: "*the province's approval of the Project "Building Yen Bai Tourism Brand and Promoting Tourism from 2020 to 2030" through Decision No. 766/QD-UBND dated April 17, 2020, reflects the province's commitment to promoting a competitive and sustainable tourism industry through digital means*". These efforts represent significant progress in state management and policy-making to facilitate DT in Yen Bai's tourism sector, especially community tourism.

4.1.2. Current status of digital human resources

Yen Bai has a young and abundant human resource, with over 60% of the working-age population (equivalent to 535,000 people). However, according to the interview results of Ms. Hoang Thi Van Mai - Deputy Chief of Office of the Department of Culture, Sports and Tourism of Yen Bai Province: "*the number of untrained workers without degrees or certificates in Yen Bai province by 2022 is still about 181,370 people, accounting for 33.9%. In addition, nearly 80% of the province's population and labor force are concentrated in rural areas, with over 57% being ethnic minorities*". These factors pose significant challenges to the province's digital transformation, especially in the tourism sector, where the application of technology plays a vital role in improving service quality and competitiveness. Recognizing the importance of human resource development, Yen Bai province has implemented many training activities, raised awareness, and supported the local tourism industry in building a digital workforce. The province's DT plan for 2023-2030 sets an ambitious goal: ensuring that 100% of civil servants and public employees are trained in basic digital skills, including data mining and technology use. The plan also hopes to train a generation of Yen Bai people who are proficient in digital technology and equipped to meet the needs of the Fourth Industrial Revolution (Baoyenbai, 2023).

In 2023, the Department of Culture, Sports, and Tourism, in collaboration with VNPT Yen Bai, organized training sessions for more than 200 tourism-related organizations and individuals in nine districts, towns, and cities. These training sessions focused on business information management, content updates, and advanced technologies such as 360-degree images, 3D models, Flycams, and Mapping to develop innovative tourism products. This initiative is essential to integrating digital tools into the local tourism industry, enhancing the province's attractiveness to domestic and international visitors (baoyenbai, 2023b).

On December 10, 2023, the Department of Information and Communications, in collaboration with Viettel Yen Bai and a technology company, launched the pilot project "Public AI Education." The project was inspired by the "Public Education" literacy movement, aiming to democratize knowledge about AI and help people apply AI to their work and daily lives. Within six months of its launch, the project exceeded expectations, with 151 members (302% of the target) and 37 AI classes (154% of the target) with the participation of 2,500 people (500% of the target). The initiative also produced 100 videos and training materials, and by the end, 600 individuals had learned how to use AI effectively, achieving 400% of the planned results. On March 29, 2024, the Department of Information and Communications organized a training session on digital tools to promote Yen Bai's image and tourism online. The training session was attended by 60 trainees, including civil servants and press officers, who were trained in using AI to create and manage digital content, such as writing articles, processing images, and analyzing trends. These skills are crucial to building compelling digital stories that attract tourists' attention, boosting the province's visibility and attractiveness in the competitive tourism market (baoyenbai, 2024b; Yenbai, 2024).

In addition to these initiatives, on March 15, 2024, the Yen Bai Farmers' Association signed a DT cooperation plan for 2024–2025 in collaboration with the Department of Information and Communications. The program aims to equip more than 30% of farmer members with AI skills by the end of 2025. The plan includes educating farmers about digital technology and AI, emphasizing their application in household economic development and agricultural production. By empowering farmers with digital tools, the program supports them in engaging in financial activities, including rural tourism, diversifying their income sources, and enhancing their economic resilience. Furthermore, in 2024, the Department of Information and Communications organized a DT startup training program for young people in collaboration with the Yen Bai Youth Union. Participants, primarily young entrepreneurs or those involved in startup initiatives, are trained in the fundamentals of digital transformation, including leveraging social media platforms like TikTok for business. The program covers creative thinking, market research, and professional online sales channel development, equipping young entrepreneurs with the skills needed to overcome the challenges and opportunities of the digital economy.

4.1.3. Digital infrastructure

In the first half of 2024, Yen Bai province has made significant progress in its DT goals, significantly expanding mobile network coverage and eliminating areas without 3G and 4G signals in remote villages and hamlets. By mid-2024, the province had fully covered broadband fiber optic cable to all communes, wards, and towns. In addition, according Ms. Nguyen Thi Tot - Department of Culture and Information of Yen Binh district - Department of Culture, Sports and Tourism of Yen Bai province: "*4G mobile services have been expanded across the province, supported by 2,554 broadcasting stations, ensuring that all central areas of communes, wards, and towns can access broadband mobile services. Notably, 99.04% of villages, hamlets, and residential groups (1,343/1,356) have been covered by mobile networks, of which 97.1% have 4G coverage. The rate of households using broadband fiber optic Internet services reached 62%".* In addition, 5G mobile networks have been installed and operated in three key localities: Yen Bai City, Nghia Lo Town, and Van Yen District. The rate of households using pay TV services and digital platforms was 49% (baoyenbai, 2024c).

The province also prioritizes high-speed Internet services and provides tourists free wireless Internet access at most central tourist attractions and service establishments. This initiative, funded by the state budget or through socialization efforts, ensures that visitors have seamless connectivity, enhancing their overall experience in Yen Bai. In addition to telecommunications infrastructure, the province has achieved significant success in several digital society indicators, surpassing its set targets. By 2024, 80% of adults owned smartphones, and 65% used e-payment services. Furthermore, 77% of community cultural houses were connected to the Internet, a significant improvement that promotes digital literacy and greater participation in online activities, including e-tourism.

In some areas of the province, digital technologies have been deployed to improve the quality of tourism and agricultural services. For example, the "Smart Traceability" solution for specialty products such as Shan Tuyet Suoi Giang tea, Van Chan district, Dai Minh grapefruit, Dai Minh commune, and Yen Binh district. This initiative aims to strengthen the brand value of these local specialty products by providing consumers with verified information on the origin of the products, thereby promoting trust and supporting sustainable development in the region.

4.1.4. Current status of electronic distribution and promotion

In recent years, Yen Bai province has invested significantly in many communication channels to promote and distribute tourism products, focusing on applying information technology and digital media. On June 20, 2023, the Department of Culture, Sports and Tourism of Yen Bai province issued Plan No. 130/KH-VHTTDL to pilot the provincial Tourism Information Portal and Tourism Application such as Yen Bai-S Citizen Application, Yen Bai Tourism Information Portal, with the official domain name at https://yenbaitourism.vn. This plan aims to integrate tourism information comprehensively and digitize data on tour guides, travel agencies, accommodation establishments, restaurants, tourist attractions, and other tourism-related products. The application of information technology for digital tourism aims to create expected benefits for tourists, management agencies, and businesses. The main activities in the first phase of the plan include piloting the Tourism Portal and Tourism Application, upgrading the interface of the Yen Bai Provincial Tourism Portal, establishing a steering committee to implement the plan, training staff on data collection, processing, and updating information into the system and training on using the portal. The next phase includes reviewing and standardizing data of tourism businesses for integration into the system, ensuring that people, businesses, and government agencies can access and use it seamlessly through connection with applications such as the Yen Bai-S Citizen Application and the Provincial Electronic Information Portal.

In addition, the promotion and distribution of tourism products have been enhanced through online channels, including social media platforms and e-commerce websites. According Mr. Pham Viet Phuong - Director of the Center for Monument Management and Tourism Development of the Department of Culture, Sports and Tourism of Yen Bai province: *"by the end of February 2024, 201 locations, including accommodation establishments, restaurants, and 106 tourist attractions across the province, had been selected for digitization and uploaded to the portal. Information updates for these establishments have reached 100% at this point. The portal has also published over 80 news articles and events, attracting more than 15,000 followers and more than 293,000 visits from domestic and foreign users"*. In addition, districts, towns, and cities in Yen Bai province have set up their tourism introduction pages on social media platforms such as Zalo and Facebook and specialized sections on their electronic portals. The Department of Culture, Sports and Tourism has also created and managed the YouTube channel Yen Bai Tourism, which introduces videos about the province's culture, landscapes, and people to promote local tourism to domestic and international audiences". Since its launch in January 2024, the channel has published 18 videos, attracted 45 subscribers, and recorded 558 views as of July 25, 2024 (baoyenbai, 2024a).

Mr. Giang A De - Homestay Hello Mu Cang Chai, La Pan Tan commune, Mu Cang Chai district, Yen Bai province believes that *support and investment from management agencies, demonstrated through legal documents and training programs, have equipped tourism businesses and individuals in Yen Bai with the necessary awareness and skills to participate in e-commerce platforms.* Service providers in districts such as Mu Cang Chai, Van Chan, Yen Binh, and Nghia Lo town have listed and sold their services on e-commerce sites such as Booking.com and Traveloka. However, the quality of images and information about accommodation facilities on these platforms could be better, and the number of facilities listed in search results is still modest.

In the agricultural sector, the Department of Industry and Trade of Yen Bai has cooperated with businesses to list many of the province's OCOP products on e-commerce platforms such as www.voso.vn and www.buudien.vn. By the end of 2022, there were 107,131 accounts on these two platforms, of which Yen Bai ranked 15th out of 63 provinces and cities in terms of the number of active accounts. The number of shopping transactions on these platforms reached 7,739, 12 times higher than in 2021. In the first quarter of 2024 alone, 145 OCOP products of Yen Bai were listed on www.buudien.vn, generating 1,860 transactions totaling 190 million VND.

In the first nine months of 2023, the Department of Industry and Trade supported 20 businesses to set up online stores on domestic e-commerce platforms such as Sendo, Lazada, and Shopee. As of October 2023, nearly 1,000 companies and more than 600 Yen Bai OCOP products were sold on these platforms. In addition to supporting businesses listing products on domestic e-commerce platforms, the Department of Industry and Trade of Yen Bai coordinates with the Trade Promotion Agency (Ministry of Industry and Trade) to support businesses accessing international e-commerce markets such as Alibaba and Amazon. A notable successful example is Kien Thuan General Service Cooperative, which specializes in producing green tea and black tea. Before joining Alibaba.com, 80% of the cooperative's revenue came from the domestic market, and the remaining 20% came from exports. After joining Alibaba.com, this ratio was reversed, and the cooperative's export revenue through Alibaba.com reached 1 million USD in 2020. By 2022, the cooperative's total income from domestic and international markets exceeded 50 billion VND.

Yen Bai's proactive approach to leveraging digital platforms to distribute tourism and agricultural products has significantly increased market reach, benefiting local businesses and the provincial economy. Continuous efforts to improve the quality and consistency of digital content and expand the presence of local products on these platforms are essential to sustain and grow.

4.2. Discussion

4.2.1. Achievements

Yen Bai, a province with unique natural conditions for agriculture and forestry, is a prime location for rural tourism development. In 2023, the province's agricultural growth rate of 5.29% ranked in the top 10 nationwide and 3rd out of 14 provinces in the Northern Midlands and Mountains region. By the end of 2023, the province had certified 234 OCOP products, including 25 products meeting 4-star standards and 209 products meeting 3-star standards. These products, including agricultural goods and local tourist attractions, are a testament to Yen Bai's potential in rural tourism (baoyenbai, 2023a; nongnghiep.vn, 2024; yenbai, 2024).

With its geographical location in the center of the Northern mountainous and midland region, Yen Bai has advantages in regional cooperation and linkage, building inter-provincial tours, and organizing cross-tourism communication activities. The province has participated in the tourism development cooperation program between Ho Chi Minh City and eight extended Northwestern provinces from 2021 to 2025. Yen Bai's tourism activities have made significant progress in recent years, reflected in the number of tourists and revenue statistics. DT and rural tourism business development are exciting to Yen Bai province. Based on the state's directives, the province has issued many plans and implemented training activities to raise officials' and people's awareness of DT. The Yen Bai Province DT Project for the 2023-2030 period aims to have 100% of cadres, civil servants, and public employees trained and fostered in basic digital skills, thereby participating in exploiting data and digital technology, meeting the requirements of the 4.0 industrial revolution. Many training programs have been organized to support businesses and people in improving their IT skills and effectively exploiting online communication channels.

Developing digital infrastructure is an essential goal of Yen Bai province, with main contents such as investing in developing data center infrastructure, cloud computing, AI technology, blockchain, IoT, and infrastructure serving e-commerce. The province has cooperated with large technology corporations, typically the Military Industry - Telecommunications Group (Viettel), to realize the set goals. In 2022, Viettel supported Yen Bai province in many areas, from providing smart devices to poor households to supporting funding for DT projects.

Positive signals from DT in rural tourism business activities in Yen Bai are demonstrated by the fact that the province ranked 15th out of 63 provinces and cities in the DT Index (DTI) in 2023, in which the DTI index on digital economy ranked 7th out of 63. People have been equipped with basic knowledge of information technology, helping them apply it in the tourism business. Technology and online communication have been widely deployed in local rural tourism activities, with innovative traceability projects for agricultural products and the active participation of companies in taking advantage of electronic distribution and promotion channels.

4.2.2. Limitations and causes

Limitations

Despite many significant achievements, the DT process in CBT business in Yen Bai still faces the following main limitations:

- Regarding the distribution of agricultural products: Despite the support from government agencies in accessing digital platforms, the number of OCOP agricultural products and stalls on major e-commerce platforms such as Shopee and Lazada still needs to be increased. This reduces the accessibility of products to consumers, limiting opportunities for market expansion.

- Regarding cross-border e-commerce, only Kien Thuan General Service Cooperative is a typical success on international trading platforms, while the province still needs to replicate this model. This is a big challenge in enhancing the value and expanding the local tourism and agricultural products market.

- Presence on online booking platforms (OTA): Although some accommodation establishments participate in OTAs, the number remains insignificant. Moreover, the images and information posted could be more attractive, reducing their competitiveness in the online market.

- Effectiveness of tourism communication: Although the province has developed many diverse tourism communication channels on digital platforms, the effectiveness still needs to be high. This is reflected in low visits, views, and followers. For example, the YouTube channel "Yen Bai Tourism," as of July 25, 2024, has posted 18 videos but only has 45 subscribers and 558 views. The "Yen Bai Tourism" application on CH Play has only reached over 50 downloads after over a year of launch (Dulichyenbai, 2024).

- Human resources: The Yen Bai tourism industry needs more human resources, especially those with high professional tourism and DT skills. This limits the ability to develop and apply new technologies in the tourism sector.

Causes of limitations

Although Yen Bai province has focused on and invested in digital transformation, including in the field of rural tourism business, this process still has limitations due to the following reasons:

- Lack of time to develop digital skills and thinking: DT in Yen Bai, especially in a rural tourism business, was only promoted after the COVID-19 pandemic. Therefore, people's digital skills and thinking must still be mature and ripe. Rural tourism activities are mainly associated with farmers' lives, so stakeholders need more time and vital investment to succeed in online distribution and promotion.

- Training and developing human resources: The workforce must be professionally trained to improve service quality and establish accommodation facilities. However, with 80% of the population and workforce concentrated in rural areas, more than 57% are ethnic minorities, and most have not received vocational training, developing digital human resources for the tourism industry is a significant challenge. This problem cannot be solved in the short term, requiring long-term investment and support from relevant authorities and organizations.

4.2.3. Solutions

Yen Bai is currently at a critical juncture where DT, particularly in the context of smart tourism, has never been more crucial. The province strives to position itself as an appealing destination, aligning with the fourth industrial revolution. In light of this, the authors have formulated a DT implementation model for local tourism development, considering the current situation and future prospects (Figure 1).

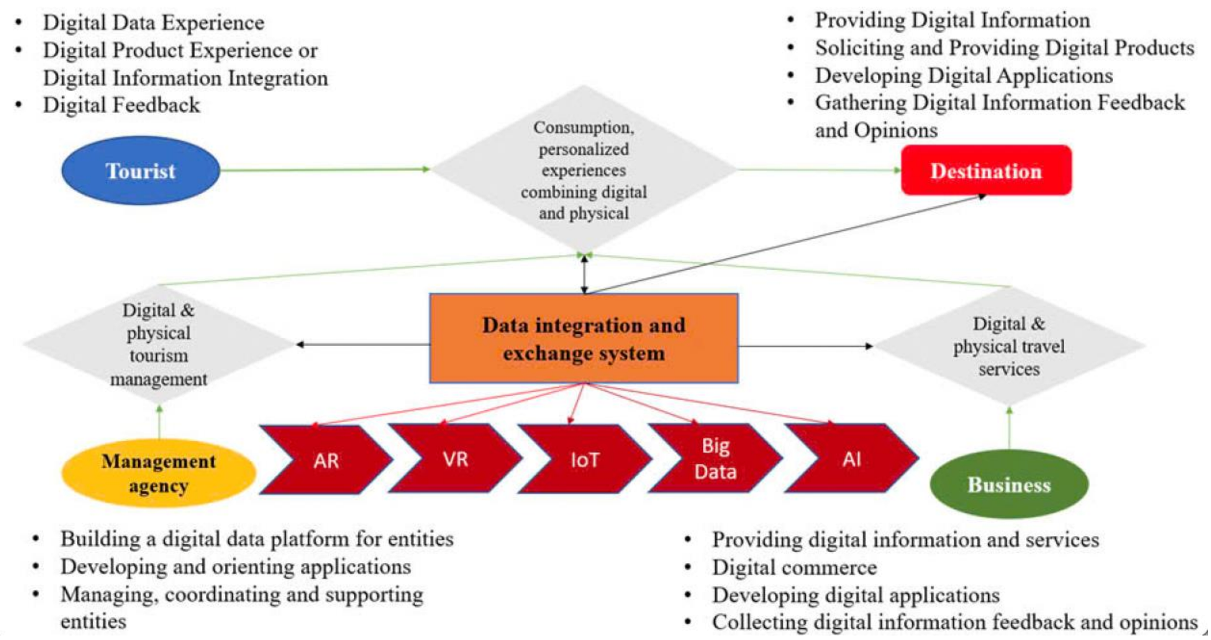

Figure 1: The smart tourism ecosystem model integrating digital technology

Source: The proposed by the authors based on the National Tourism Administration's Master Plan for IT Application (2024)

The model is designed to foster a smart tourism ecosystem, leveraging a blend of digital technology and best practices. This approach facilitates seamless data exchange among critical stakeholders and promises many benefits, including improved efficiency, enhanced visitor experiences, and sustainable tourism development. Moreover, the model offers a comprehensive application orientation, paving the way for a unified, integrated database and a smart tourism ecosystem.

- Yen Bai's provincial, district, and commune management agencies must manage and monitor the entire tourism system. Management agencies need to have an overview of data and activities of destinations, tourists, and businesses to adjust policies, orient sustainable tourism development, and ensure legal regulations. They use the integrated system to manage smart tourism, analyze big data, optimize destination management, and make timely decisions based on real-time data. The authors recommend that management agencies focus on building a digital data platform for entities, managing, coordinating, and supporting entities to compete equally between traditional and modern models, and protecting tourists. However, it is necessary to emphasize transparency, quality, privacy, and environmental protection.

- Destinations play a crucial role in the DT as the providers of services and experiences for tourists. By digitizing information and applying advanced technologies, they can produce videos, products, and highly competitive tourism services. This not only improves their competitiveness but also enhances the overall tourist experience. Data from destinations, including existing services, promotions, and tourism activities, are regularly updated through the integrated system, allowing for the adjustment of tourism programs and services to suit the needs of tourists.

- Local tourism service providers (accommodation, transportation, food, tours, etc.) use information from tourists and destinations to optimize business operations, improve efficiency, and create personalized tourist services. Businesses interact with the system by providing data about their services and receiving analytical data about visitors' tastes and needs to adjust business strategies.

- For tourists and users of tourism services and experiences at destinations, their feedback is of the utmost importance. The system collects and analyzes information about tourists and their consumption behavior to provide appropriate services and better meet individual needs. Tourists receive data from the system through various information channels and provide data on their needs, behaviors, and feedback after the experience. This feedback loop is crucial for the system to optimize services and ensure a satisfying tourist experience.

- The integrated data exchange system is the core of the smart tourism model, where the process of integrating data from multiple sources and exchanging information between stakeholders takes place. This system is based on five leading technologies:

- Internet of Things: Connect smart devices and real-time data monitoring systems at destinations to provide travelers with personalized experiences.
- Big Data: Collect, analyze, and store large amounts of data on traveler behavior, travel trends, and business performance, providing recommendations and improving services.
- AI: Use AI to analyze data and predict trends, optimizing travel experiences, from choosing destinations to suggesting services suitable for each traveler.
- VR/AR: Virtual reality (VR) and augmented reality (AR) technologies bring immersive travel experiences. They allow travelers to explore destinations in advance or take virtual tours, giving them a more realistic view before making travel decisions.
- Blockchain: Blockchain ensures transparency and security in tourism transactions, from booking to payment to identity authentication, helping to reduce the risk of fraud, increase trust, and improve supply chain management in the tourism industry.

The tourism model that combines digital technology and practice enhances the tourist experience and helps businesses optimize services and management agencies monitor more effectively. The combination of the Internet of Things, big data, and artificial intelligence is the critical factor that helps this model operate, creating a smart and sustainable tourism ecosystem.

In addition, some other solutions are proposed, specifically as follows:

- Infrastructure development: Continued investment in digital infrastructure, especially in rural and remote areas, is essential. Expanding broadband access and providing necessary technical support will enable wider adoption of digital technologies. Given the mountainous terrain, Yen Bai needs a detailed roadmap and plan that specifies timelines, resources, and telecommunications infrastructure partners to reduce the number of local signal dips in the shortest possible time.

- Capacity building: Expanding training programs and workshops to improve digital literacy among tourism operators and local communities is essential. Training tailored to the specific needs of different stakeholders will ensure that they can effectively engage with digital tools. Especially in the field of community tourism, the participation of local people in the service provision process is extensive, so the dissemination of skills needs to be widely deployed, starting from basic digital skills to suit the starting point of people's awareness. In addition to digital technology skills, individuals and organizations managing tourist destinations or operating tourism businesses must also be equipped with strategic thinking, knowledge of electronic markets, and system management skills.

- Public-private partnerships: Encouraging collaboration between the government, the private sector, and educational institutions can bring the expertise and resources needed to drive DT. Pilot projects and case studies can serve as models for broader applications. Combining knowledge and financial resources between the province and businesses and educational institutions will help accelerate the DT process in the community tourism sector and build a general local digital economy. With the diversity and uniqueness of agricultural products and tourism resources, Yen Bai can expand cooperation with large e-commerce enterprises in creating training programs and supporting people to sell on reputable e-retail channels or promote communication about tourism activities and local tourist destinations on social networking platforms.

- Policy improvement: Strengthening the policy framework to support DT and ensuring consistent implementation at all levels of government will create a favorable environment for the development of digital tourism. Policies must aim to facilitate digital human resource development, improve digital infrastructure, and enhance regional cooperation and public-private partnership in digital transformation.

- Strategy development**:** The development of strategies and action plans orients the correct thinking and implementation methods by the socio-economic situation in each locality. In Yen Bai province, each key tourist area has its specific advantages, so when developing strategies and action plans, it is necessary to pay attention to the particular characteristics to issue appropriate directives.

- Development of tourism databases: Databases on travel agencies, tour guides, tourist accommodation establishments, and tourist areas - attractions, restaurants, standard shopping places, entertainment venues, etc. will be the premise for implementing online tourism platforms and applications, and the same time, a valuable information channel for local managers and policymakers. Although there has been orientation and practice in building electronic information channels to promote tourism in Yen Bai, data on tourism and community tourism needs to be completed and arranged scientifically and reasonably, leading to low channel efficiency and not reaching many users. Therefore, it is necessary to have a specific action plan for implementing a common and unified tourism data system locally.

In conclusion, although Yen Bai province has made significant strides in digitizing the tourism sector, primarily CBT, several challenges remain. Addressing these challenges through targeted infrastructure development, capacity building, and strategic partnerships will be essential to realizing the full potential of the province's DT.

5. Conclusion

DT in the tourism sector of Yen Bai province offers promising opportunities to enhance CBT and promote sustainable economic growth. However, successful implementation of digital initiatives requires addressing significant challenges, including limited infrastructure, gaps in digital literacy, and coherent strategies tailored to local capacities and needs. The findings of this study highlight the importance of stakeholder collaboration, targeted investments in digital infrastructure, and appropriate training programs to bridge the digital divide. By adopting these strategies, Yen Bai can fully leverage digital technologies to enhance tourism services, preserve cultural and natural heritage, and promote economic development. The insights gained from this research can serve as valuable guidance for other regions facing similar challenges in their DT journey.

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