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Green Logistics Development in Vietnam: An Assessment of Impact Factors and Recommendations from an Enterprise Perspective

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ABSTRACT

Under the growing pressure of environmental protection, green logistics is an unavoidable trend of development within the context of globalization and the commitment of enterprises towards sustainable development. In Vietnam, green logistics has been increasingly adopted by enterprises and, although there has been some positive initial progress, it still exposes numerous shortcomings, particularly in the case of small and medium enterprises that still face numerous challenges. With a literature review and preliminary surveys in several enterprises in Hanoi, the study has identified five key groups of factors that affect the extent of green logistics adoption from an enterprise perspective: (1) Managers' awareness of the environment; (2) Financial capacity; (3) Logistics infrastructure and technology; (4) Government's supportive policies; and (5) Capability of digital technology adoption. Among them, the prominent obstacles include high initial investment, inadequate infrastructure, and poor-oriented policies. However, some enterprises have started their positive transition by using clean vehicles and digitizing their supply chains that shows both potential and internal motivation for green transformation in logistics industry. From findings of the study, the article gives a number of recommendations to promote the development of green logistics in Vietnam, including completion of a legal framework, increase of financial support, investment in infrastructure, and enhancement of technological capability for enterprises. The group of authors expects to provide a practical foundation for policymaking as well as to orient Vietnamese small and medium enterprises in specific actions in their transition toward environmentally friendly logistics models.

Keywords: Green logistics, sustainable development, private enterprises, infrastructure, environmental policy.

INTRODUCTION

Rationale

Green logistics is becoming an essential requirement in restructuring the global supply chain toward the sustainable development. Increasingly stringent environmental standards and pressures from new trade agreements such as the CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership) and the EVFTA (European Union - Vietnam Free Trade Agreement) compel enterprises to integrate "green" elements into their logistics operations. Logistics must not only ensure operational efficiency but also meet targets of emission reduction, energy saving, and mitigation of negative environmental impacts.

In Vietnam, although the logistics industry is considered one of the pillars to support the economic growth, its operational efficiency and the application of green solutions are still limited. According to the Vietnam Logistics Report (Ministry of Industry and Trade, 2023), logistics costs account for about 16.8% of GDP, which is

significantly higher than the regional average. The infrastructure has not been synchronized, technological capability fails to meet the requirements of green transformation, while solutions such as transportation optimization , use of renewable energy, recycling of packaging or digitization of supply chains have not been comprehensively implemented.

Especially, the group of small and medium enterprises, which accounts for more than 97% of enterprises in the industry, is facing the most obstacles in implementing green logistics as a result of their limitations in finance, professional human resources, and insufficient specific supportive policies. The transition to an environmentally friendly logistics model among these enterprises is generally spontaneous, lacks long-term strategies and clear orientations. Facing the above situation, it is necessary to study the factors that affect the implementation of green logistics in enterprises, thereby to provide a scientific basis for policymaking and recommend suitable solutions for practical conditions.

In that context, green logistics has emerged as an inevitable trend with the influence from many internal and external factors. Studies in the world have shown the importance of top management's awareness (Rao & Holt, 2005), financial capacity and investment in technology (Chow et al., 2007), and the impact of public policies and infrastructure (Trivellas et al., 2020). In Vietnam, several research works (Nguyen Thi Huong, 2023; Le Vu Huy, 2023; Tran Thi Hanh & Nguyen Van Tam, 2022) have initially mentioned barriers and proposed solutions, but most of them are still theoretical, lack intensive quantitative surveys and have not integrated impact factors in a comprehensive research model.

From the above-mentioned gaps, this study was conducted to synthesize the existing theories and preliminarily survey the practices at some logistics enterprises in Hanoi. The study aims to identify and analyze groups of factors that have a significant impact on the ability to adopt green logistics from the enterprise perspective, thereby recommend some feasible policies and solutions to facilitate the transition to a green logistics model in line with the context and the orientation of sustainable development of Vietnam.

LITERATURE REVIEW

Green Logistics is a core concept in the sustainable development strategy of modern enterprises that reflects the integration of environmental goals into the traditional logistics chain. Wu & Dunn (1995) and Rodrigue et al. (2012) argue that green logistics is the process of planning, organizing, and controlling logistics activities to mitigate negative impacts on the environment. These activities include reduction of greenhouse gas emissions, energy saving, use of recycled materials, efficient waste management, transportation optimization routes and adoption of clean technologies in packaging, storage and delivery.

Beamon (1999) emphasizes that green logistics does not exist independently but is an important component of the sustainable supply chain management (SSCM), of which the three pillars - economy, environment and society - should be reviewed simultaneously and harmoniously. This requires enterprises to change their thinking from maximization of short-term cost efficiency to a holistic and long-term approach, of which environmental factors are integrated into all decisions related to logistics.

In practice, green logistics is not only an ethical or policy-compliant choice but also a strategy for value creation. Srivastava (2007) and Carter & Rogers (2008) indicate that green logistics helps enterprises reduce their operating costs in the long term through energy savings, reuse of materials, and transportation optimization. Enterprises that adopt green logistics can also enhance their brand image, meet the increasing expectations of consumers and regulatory agencies, thereby create sustainable competitive advantages in the market.

Besides, in the context of globalization and international integration, increasingly stringent environmental standards in many markets such as the EU, USA, Japan, etc. force Vietnamese enterprises to transform in green logistics direction if they want to maintain their export capacity and participate in the global supply chain. Zhang et al, (2020) emphasize that investment in green logistics is not only the satisfaction of external requirements but

also a long-term strategy to improve competitiveness, adaptability and resilience in the context of climate change and market uncertainties.

Understanding Green Logistics Development in Enterprises

Green logistics development reflects enterprises' implementation of activities to mitigate environmental impacts throughout the entire supply chain: from procurement, transportation, storage to distribution. This is the primary dependent variable in the model that is expressed through practices such as use of clean energy, transportation optimization, investment in environmentally friendly technology and compliance with green standards in operations.

It is understood that green logistics development in an enterprise is the process of planning, organizing and implementing logistics activities aiming to mitigate negative impacts on the environment while ensuring operational efficiency and sustainability in the supply chain. This concept reflects the commitments and actions of an enterprise in integrating "green" elements into all stages of logistics, including procurement of raw materials, transportation, storage, purchase order processing, distribution, and management of product life cycle.

At present, green logistics is not merely individual technical solutions, but requires enterprises to develop a comprehensive strategy towards environmentally friendly operations. Some specific manifestations can be mentioned, including the use of fuel-efficient or renewable energy-powered vehicles; optimization of delivery routes to reduce CO_2 emissions; reuse and recycling of packaging; investment in green technology and smart management systems; and compliance with environmental standards in operations and supply chain management.

In the research model, green logistics development is identified as a dependent variable that reflects the results of being influenced by many factors such as top management's awareness, financial capacity, technological capability, infrastructure quality and policy support. The extent of green logistics development can be measured by quantitative indicators or scales to assess the implementation of environmentally friendly activities in enterprises.

Development of Hypotheses

With increasingly urgent requirements for emission reduction and efficient use of resources, green logistics is not only a solution to mitigate environmental impacts but also a sustainable development strategy for businesses. However, the implementation of green logistics in Vietnam is facing many obstacles such as high investment, inadequate technical infrastructure, lack of efficient supportive policies and limited technological capability, particularly in small and medium enterprises.

To clarify the factors that affect the ability to develop green logistics from the enterprise perspective, the study recommends a theoretical model with five independent groups of factors, aims to test the relationship between each factor and the dependent variable, which is the extent of green logistics development in enterprises.

Hypothesis H1. *Managers' awareness of the environment*

This is the understanding, responsibilities and commitments of enterprises' top management regarding environmental issues and sustainable development. Managers with high awareness will proactively integrate environmental factors into their business strategy and invest in green technology (Lee, 2008).

Hypothesis H2. *Financial capacity of enterprises*

Because green logistics requires high investment at the beginning, enterprises with strong financial capacity will be able to access green technology, innovate their vehicles and infrastructure, and withstand risks in the early stages of implementation (Zhu & Sarkis, 2004).

Hypothesis H3. *Logistics infrastructure and technology*

Modern logistics infrastructure and technology help optimize transportation operations, reduce emissions, and improve the efficiency of supply chains. Technologies such as TMS, WMS, IoT, etc. play a key role in the implementation of green logistics (Huang et al., 2012).

Hypothesis H4. Government's supportive policies

Government support through tax policies, preferential credits, environmental regulations and encouragement of innovation can facilitate enterprises in transforming to green logistics (McKinnon, 2010).

Hypothesis H5. *Capability of digital technology adoption*

Enterprises that are able to integrate digital technologies such as AI, Big Data, blockchain or smart sensors will optimize their supply chain management and improve environmental efficiency (Sarkis et al., 2011).

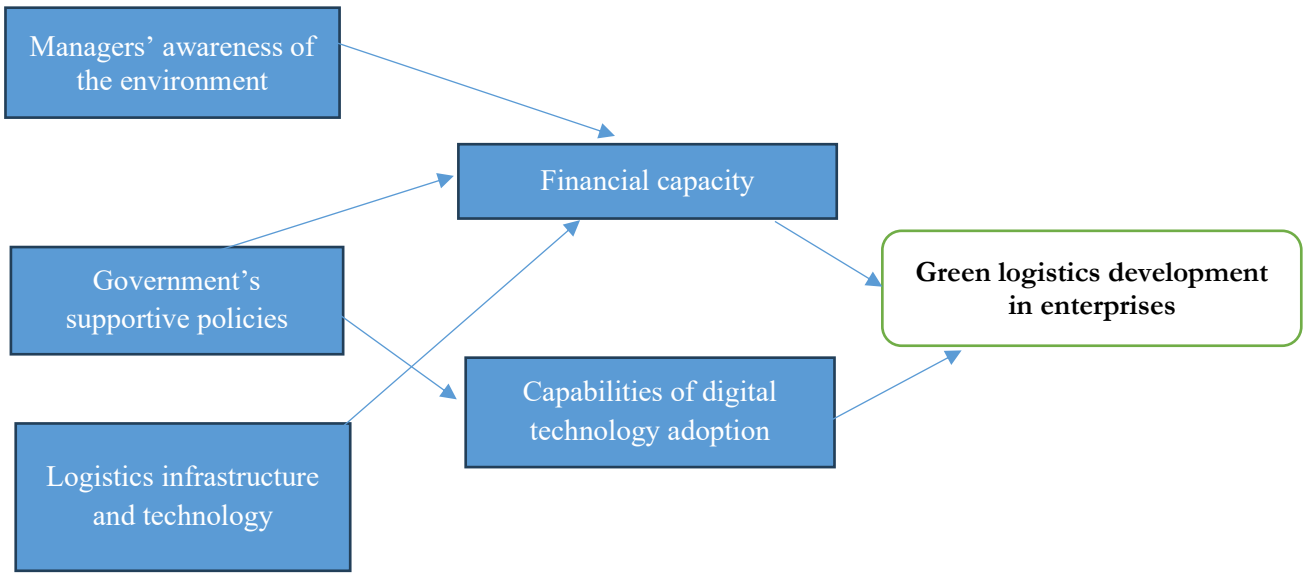

Figure 1: Recommended research model

Source: Recommendations of the authors

Through the research model (Figure 1), it can be seen that green logistics development in enterprises is considered the primary dependent variable in the research model; it reflects enterprises' implementation of activities to mitigate environmental impacts throughout their supply chains. The research model shows that green logistics development in enterprises is affected by five key groups of factors.

- First, managers' awareness of the environment (Hypothesis H1) has not only the strongest direct influence on green logistics development in enterprises but also indirect influence on financial capacity, capability of digital technology adoption and policy access through budget allocation decisions, technology investment orientations, and proactive grasp of policies.

- Second, the financial capacity (Hypothesis H2) has a direct influence on green logistics development in enterprises; it is an intermediary factor in deciding the investment in logistics infrastructure and digital technology.

- Third, logistics infrastructure and technology (Hypothesis H3), which are influenced by financial capacity, also directly impact the development of green logistics in enterprises.

- Fourth, Government's supportive policies (Hypothesis H4) have a significant supporting role in the development of green logistics in enterprises with not only direct influence but also indirect influence through the promotion of financial capacity and logistics infrastructure and technology with financial incentives and digital transformation.

- Last but not least, the capability of digital technology adoption (Hypothesis H5) has a significant influence on the development of green logistics in enterprises and is affected by factors such as managers' awareness of the environment, financial capacity and Government's supportive policies.

RESEARCH METHODOLOGY

Qualitative Research

The qualitative research was conducted to develop a theoretical foundation and establish a research model that is suitable for the Vietnamese context. The authors conducted a systematic review of domestic and foreign science

research works related to green logistics, and combined in-depth interviews with 5 experts who are working in logistics industry and supply chain management in Vietnam. The interviews were conducted between March 9, 2025 and March 21, 2025 to obtain intensive information on the practical implementation of green logistics and the impact factors.

The results of the literature review and interviews enable the adjustment of the initial research model and the development of a preliminary scale. At the same time, five key groups of factors affecting the implementation of green logistics in enterprises were identified, including: (1) Managers' awareness of the environment; (2) Financial capacity; (3) Logistics infrastructure and technology; (4) Government's supportive policies; and (5) Capability of digital technology adoption. These factors play a key role in analyzing the impact factors and obstacles of enterprises in their transformation to an environmentally friendly logistics model in Vietnam.

Quantitative Research

With the theoretical model that was adjusted in the qualitative research, the authors developed a survey questionnaire with observed variables measured by the 5-point Likert scale (from 1 - completely disagree to 5 - completely agree). Data was collected from 136 managers and personnel related to logistics activities at enterprises in Hanoi by the convenient sampling method and combining direct and online surveys from March 28, 2025 to April 24, 2025.

The data was processed and analyzed using SPSS version 26.0 software, including the following main steps:

1. Testing the reliability of the scale using Cronbach's Alpha;
2. Using the Exploratory Factor Analysis (EFA) to determine the structure of groups of factors and testing the discrimination among variables;
3. Using the Multivariate linear regression analysis to assess the impact of each factor on the enterprises' implementation of green logistics.

Survey Samples and Classification by Enterprise Size

The study was conducted with 136 valid questionnaires collected from logistics enterprises in Hanoi - the key economic, industrial and logistics center of Northern Vietnam. This area is chosen to both ensure access to enterprises in many different industries and fit the trend of logistics development concentrated in large cities.

The survey samples were intentionally designed to comprehensively and multi-dimensionally reflect the implementation of green logistics in the current context of Vietnamese enterprises, particularly in the small and medium-sized enterprises, which account for a large proportion of the national economic structure. The enterprises participating in the survey are divided into three main fields: production - processing (58.8%), logistics services (28.7%) and trade - distribution (12.5%). This structure of business fields reflects the key role of production and logistics in the supply chain, and shows the close connection between the links of cargo operations from the place of production to consumers.

Beside the diversity of business fields, the research samples also show the abundance of the workforce size, years of operation, and job titles of the respondents. This diversity itself ensures the reliability and representativeness of the survey data, thereby creates a solid foundation for analyzing, evaluating data and drawing conclusions of high practical and academic value.

- Regarding the workforce size, the survey samples are divided into three main groups: small enterprises (under 100 employees, accounting for 41.9%), medium enterprises (from 100 to under 300 employees, accounting for 29.4%) and large enterprises (over 300 employees, accounting for 28.7%). This structure accurately reflects the current status of the Vietnamese economy, in which small and medium enterprises (SMEs) account for the majority and often face many obstacles in green transformation.

Table 1: Classification of survey samples and proportion of green logistics implementation

Enterprise size	Proportion in samples (%)
Under 100 employees	41.9%
From 100 to under 300 employees	29.4%
Over 300 employees	28.7%

Source: Synthesis of the authors' survey data

- The years of operation of the surveyed enterprises also indicate a relatively high stability, with 64.7% operating from 5 to less than 15 years, 17.6% operating in less than 5 years and 17.7% having more than 15 years of experience. The respondents to the questionnaire include top management (directors, deputy directors: 36%), middle managers (head/vice head of logistics or operations departments: 45%) and specialists of logistics/supply chain (19%). The survey of managers at professional and decision-making levels helps ensure the quality and reliability of the data.

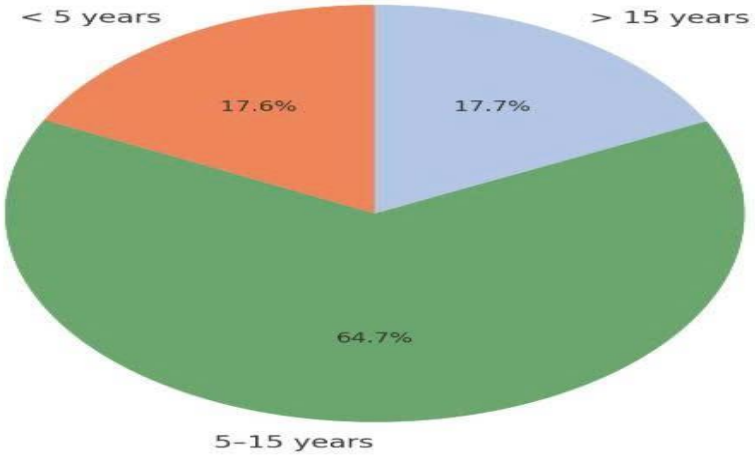

Chart 1: Distribution of survey samples by years of operation
Source: Synthesis of the authors' survey data

- Notably, in analyzing the extent of green logistics implementation by enterprise size, the results show a clear differentiation: only 22.5% of small enterprises (under 100 employees) have implemented one or more green logistics solutions in comparison with 41.2% in medium enterprises and up to 68.3% in large enterprises. This difference reflects the direct relation between enterprise size and the capability of implementing green solutions. Small enterprises often face difficulties in capital, specialized human resources and access to technology, while large enterprises tend to invest more proactively in clean transportation, supply chain management systems and digitalization of logistics operations.

Table 2: Proportion of green logistics implementation by enterprise size

Enterprise size	Proportion of green logistics implementation (%)
Small (<100 employees)	22.5%
Medium (100–200 employees)	41.2%
Large (>200 employees)	68.3%

Source: Synthesis of the authors' survey data

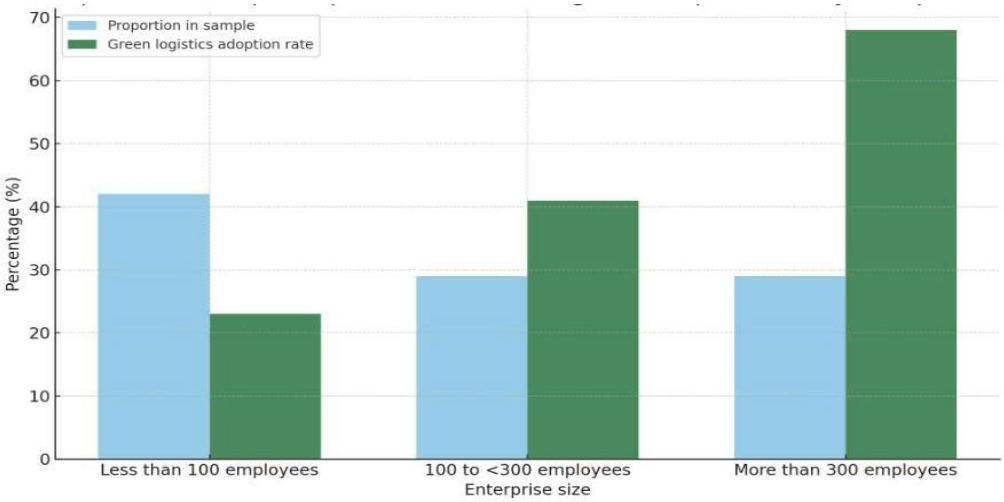

Chart 2: Comparing enterprise proportions in the sample and proportion of green logistics implementation
Source: Synthesis of the authors' survey data

Data in Figure 2 shows the relation between enterprise size and the extent of green logistics implementation. Specifically, large enterprises (over 300 employees) have the highest proportion of green logistics adoption that demonstrates efficient organization and investment in sustainable activities. Meanwhile, small enterprises (under 100 employees), although accounting for a large proportion of the total survey sample, have the lowest proportion of green logistics implementation. This result indicates that enterprise size plays an important role in promoting and implementing strategies of green logistics.

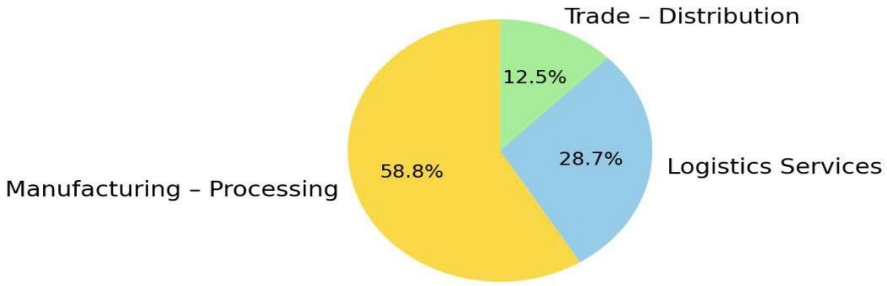

Chart 3: Distribution of survey samples by business lines

Source: Synthesis of the authors' survey data

In Chart 3, the structure of the business fields of the enterprises participating in the survey shows a clear distribution by the role in the supply chain. The group of production - processing enterprises accounts for the largest proportion (58.8%) that reflects a high dependence on logistics activities to ensure production efficiency and output distribution. The group of logistics enterprises accounts for 28.7% that plays a key role in transportation, warehousing and distribution activities. Meanwhile, the group of trade - distribution enterprises accounts for 12.5% that undertakes the role of the final connection in the supply chain, which is bringing products to consumers. This structure shows a diversity with a significant focus on the production field in the logistics value chain.

RESEARCH FINDINGS

Assessment of the Scale's Reliability

In the quantitative research, the reliability of the scale is assessed as an important step to ensure the intrinsic consistency of the observed variables in each group of factors, which can then be used in subsequent analyses such as exploratory factor analysis (EFA) and linear regression analysis. In this regard, the authors used the Cronbach's Alpha coefficient, which is a popular indicator to assess the consistency among the observed variables in the same scale.

The assessment results are shown in Table 3. According to Hair et al. (2010), the scale is considered reliable when the Cronbach's Alpha coefficient is greater than 0.7. All five groups of factors in the research model have values beyond this threshold that reflects acceptable reliability and suitability for the factor analysis.

Table 3. Assessment of the Scale's Reliability (Cronbach's Alpha)

Groups of factors	Number of observed variables	Cronbach's Alpha
Awareness of the environment	4	0.782
Financial capacity	3	0.754
Technical infrastructure	4	0.803
Government's supportive policies	3	0.768
Technology and digital transformation capabilities	4	0.871

Source: Synthesis of the authors' survey data

From the data in the table above, it can be seen that:

- The "Awareness of the environmental" group consists of 4 observed variables with a Cronbach's Alpha coefficient of 0.782 that indicates a good reliability; it reflects that all the variables in this group aim at managers' awareness of environmental issues.

- The "Financial capacity" group has a Cronbach's Alpha coefficient of 0.754, indicating that the observed variables consistently reflect the financial capacity of enterprises in green logistics activities.

- The "Technical infrastructure" group has a coefficient of 0.803, which is higher than the average, showing good stability among variables related to facilities, technology and logistics infrastructure systems.

- The "Government's supportive policies" group with a coefficient of 0.768 indicates a significant reliability, proving that all the variables properly reflect enterprises' awareness of government's support in the development of green logistics.

- The "Technology and digital transformation capabilities" group has the highest coefficient of 0.871. This shows that the variables in this group have a very high intrinsic correlation, clearly reflects the role of digital technology in green logistics activities of enterprises.

All groups of factors meet the requirement for reliability. It shows that the observed variables have high intrinsic consistency and are eligible for further analysis. In particular, the "Technology and digital transformation capabilities" group with a Cronbach's Alpha coefficient of 0.871 shows a very high consistency between the observed variables and the stability of the scale.

Exploratory Factor Analysis (EFA)

Exploratory factor analysis was conducted to determine the latent structure of observed variables, assess the reliability of the scale, and provide a basis for the next steps of analysis.

Table 4. Results of Exploratory Factor Analysis (EFA)

Criterion	Value	Description
KMO (Kaiser-Meyer-Olkin)	0.823	High adequacy (> 0.6) - Data is eligible for factor analysis
Bartlett's Test of Sphericity	χ^2 = 1024,461; df = 210; Sig. = 0.000	Statistically significant - Correlations among observed variables exist
Number of extracted factors (Eigenvalue > 1)	5 factors	Clearly defined factor structure, aligned with the theoretical model
Total variance explained	67.21%	High explanatory power (> 60%) - Satisfactory for social science research
Factor loadings	0.689 – 0.802	Acceptable (> 0.5) - Indicate good convergent validity among variables of each factor
Unidirectionality and no cross-loading	Ensured	Each variable strongly loads on a single factor only

Source: Synthesis of the authors' survey data

The results of the exploratory factor analysis (EFA) show the high reliability and structural validity of the scale. The KMO coefficient of 0.823 affirms that the data is eligible for factor analysis, while Bartlett's Test (χ^2 = 1024.461; $p < 0.001$) confirms a significant correlation among the variables. The Eigenvalue of five extracted factors is greater than 1 that exactly reflects the theoretical structure and explains the total variance of 67.21%. The observed variables have factor loadings of 0.689 - 0.802 without cross-loading that shows clear convergence and differentiation. Thus, the scale is confirmed to be suitable and reliable for the subsequent regression analysis that is used to assess the impact of the factors on the implementation of green logistics in Vietnamese enterprises.

Multiple Linear Regression Analysis

The multiple linear regression analysis was conducted to determine the influence of each group of factors on the enterprises' implementation of green logistics. The model shows a high suitability with an adjusted R^2 coefficient of 0.593, i.e., about 59.3% of the variation of the dependent variables is explained by the five independent variables in the model.

Table 5. Results of regression analysis

Independent variable	Standardized Beta	Sig.
Awareness of the environment	0.316	0.000
Technology and digital transformation capabilities	0.264	0.001
Financial capacity	0.228	0.004
Technical infrastructure	0.203	0.007
Government's supportive policies	0.187	0.015

Source: Synthesis of the authors' survey data

The analyzed data shows that "Managers' awareness of the environment" has the greatest influence ($\beta = 0.316$; $p < 0.001$). It indicates that human factors, specifically the mindset and commitment of top management, play a key role in promoting green logistics. Next is "Technology and digital transformation capabilities" ($\beta = 0.264$; $p = 0.001$) that reflects the fundamental role of technology in improving the efficiency and mitigating environmental impacts in the supply chain.

"Financial capacity" ($\beta = 0.228$; $p = 0.004$) and "Technical infrastructure" ($\beta = 0.203$; $p = 0.007$) have a medium impact, indicating that enterprises need to have sufficient financial capacity and facilities to implement sustainable logistics solutions. Finally, although "Government's supportive policies" has the lowest coefficient ($\beta = 0.187$; $p = 0.015$), it still has statistical significance and affirms the importance of the institutional environment in facilitating and encouraging enterprises to participate in green transformation. Thus, the analysis results show that the combination of awareness, internal capacity and external support are key factors to promote the implementation of green logistics in Vietnamese enterprises.

Evaluation of Perceived Impact of Influencing Factors

The consensus regarding the influence of each group of factors was assessed using the average scores on the 5-point Likert scale.

Table 6. Average score of enterprise evaluation

Factor	Mean score (1–5)	Rank
Awareness of the environment	4,23	1
Technology and digital transformation capabilities	4,05	2
Financial capacity	3,91	3
Technical infrastructure	3,76	4
Government's supportive policies	3,64	5

Source: Synthesis of the authors' survey data

The results show that "Environmental awareness" is most highly appreciated by the enterprises (mean score: 4.23). It indicates that top management' awareness and commitment are prerequisites in the development of green logistics. It proves that managers' strategic vision and long-term awareness will activate and maintain the green transformation.

"Technology and digital transformation capabilities" ranks second (mean score: 4.05) that reflects the clear impact of technology, automation, and information systems on optimization of logistics processes, reduction of emissions, and improvement of operational efficiency. Investment in technology not only brings competitive advantages but is also a key solution to implement commitments to sustainable development goals.

"Financial capacity" with a mean score of 3.91 shows both important role and common challenge, particularly for small and medium-sized enterprises in implementing green solutions that often require great initial investment.

"Technical infrastructure" with a mean score of 3.76 shows a moderate level of satisfaction. It indicates that there are shortcomings in logistics, transportation networks or environmentally friendly storage systems.

Markedly, "Government's supportive policies" is the factor having the lowest mean score (3.64). It shows enterprises' perception of inconsistency, poor efficiency, and limited accessibility of current policies. This result raises an urgent need for state management agencies to develop more transparent and efficient incentive

mechanisms, especially financial support, tax, or technical advice, to promote green transformation in the private business sector.

Nhìn chung, đánh giá từ phía doanh nghiệp khẳng định vai trò then chốt của yếu tố nội tại, đặc biệt là nhận thức và công nghệ, trong khi các yếu tố bên ngoài như chính sách và hạ tầng vẫn cần được cải thiện đáng kể để tạo môi trường thuận lợi cho logistics xanh phát triển bền vững tại Việt Nam.

Generally, enterprises' assessments affirm the key role of internal factors, particularly managers' awareness and technology, while external factors such as policies and infrastructure still need significant improvement to facilitate the sustainable development of green logistics in Vietnam.

Accessibility to Supportive Policies

An important content in the survey is enterprises' accessibility to supportive policies during the transformation to green logistics. The results are shown in Table 7 below:

Table 7. Proportion of enterprises having accessed supportive policies

Type of supportive policy	Proportion of accessibility (%)
Exemption/reduction of environmental tax	12,5%
Green credit incentives	9,8%
Human resources training on green logistics	17,6%
Support for investment in green logistics infrastructure	6,3%

Source: Synthesis of the authors' survey data

The survey results show logistics enterprises' limited accessibility to the Government's supportive policies. Specifically, the policy with the highest proportion of accessibility is "Human resources training on green logistics", but only 17.6% of enterprises benefited from it. Meanwhile, policies that have direct impact on investment decisions such as "green credit incentives" and "support for investment in green logistics infrastructure" are accessed by only 9.8% and 6.3% of surveyed enterprises, respectively.

These figures reflect a remarkable gap between policies and practical implementation in enterprises. It may be resulted from factors such as complicated procedures, access conditions that are not in line with the capacity of the majority of small and medium enterprises, and particularly limited efficiency of policy communication.

This situation shows the urgent need for completing the policy framework to support green logistics towards simplified procedures, enhanced information transparency, and development of an access mechanism that suits the size and capacity of domestic logistics enterprises. The gap between policy and practice should be narrowed to not only increase the efficiency of supportive programs but also facilitate the synchronous and sustainable green transformation throughout the logistics industry.

DISCUSSION

The results of quantitative and qualitative analysis provide a comprehensive picture of the factors that affects the implementation of green logistics in Vietnam. The research results show that the impact factors are multidimensional and interconnected. Specifically, internal factors of enterprises such as awareness of the environment, technological capability and financial capacity play a key role. However, without synchronous support from technical infrastructure and macro-level policies, the transformation will lack sustainability and be difficult to spread widely.

The Central Role of Managers' Awareness in Green Transformation

With the highest standardized regression coefficient ($\beta = 0.316$) and the highest mean score on the Likert scale (4.23/5), "awareness of the environment" is identified as the factor that has the strongest impact on the implementation of green logistics. This result is consistent with the arguments of Rao & Holt (2005) and Carter & Rogers (2008), who argued that managerial thinking is fundamental in the transformation to a sustainable supply

chain. In the practical survey, many enterprises said that green initiatives often fail to overcome the barriers of costs and short-term benefits without clear commitments from top management.

This is very important when green logistics in Vietnam is still a new concept, not yet popular and not yet integrated into overall operational strategies. Raising managers' awareness of the environment not only affects investment behaviors but also provides a basis for a green organizational culture, which helps maintain long-term transformation momentum.

Technological Capability and Differences in Implementation Capabilities Among Enterprises

With a $\beta = 0.264$ and an average score of 4.05/5, "technological capability" is the second most influential factor. Enterprises that are able to adopt digital technology, such as transportation management systems (TMS), journey monitoring, and supply chain management software, are likely to implement solutions more efficiently to optimize transportation, reduce emissions, and save energy. This is completely consistent with the theory of modern logistics by Rodrigue et al. (2012), which emphasizes the role of ICT (information and communication technology) as a pillar of green logistics.

Nevertheless, the clear differentiation in the accessibility to and adoption of technology between large and small enterprises is also clearly reflected in the results in Table 1. Only 22.5% of small enterprises (<100 employees) implement green logistics solutions, compared to 68.3% of large enterprises. It shows the need for programs to support technology transfer, digital training and popularization of green solutions suitable for small-sized enterprises that account for an absolute majority of the Vietnamese logistics industry.

Financial Barriers and Initial Investment Pressure

The factor "financial capacity" also shows a remarkable impact on the implementation of green logistics ($\beta = 0.228$; mean score: 3.91). Most of the surveyed enterprises believed that the investment in clean transport, warehouse upgrades, or applications of specialized software was much higher than their existing financial capacity. This is consistent with the conclusion of Srivastava (2007), who argued that green logistics often faces "high initial costs, long-term benefits", making enterprises hesitate to transform without initial financial support.

The presence of financial barriers also indicates the key role of green credit mechanisms and investment incentives. However, the proportion of enterprises that have accessed green credit incentives is only 9.8%, which is an alarmingly low figure. This raises an urgent need for reform of the lending procedures and conditions, as well as enhancement of communication so that enterprises can really access supportive policies.

Logistics Infrastructure and Inconsistency in Implementation

Although the "technical infrastructure" factor has a lower impact ($\beta = 0.203$), it is a common and systemic barrier. Responses from enterprises show that current warehouse systems, logistics centers, and transportation vehicles do not meet standards for energy, waste treatment, or digitalization capabilities. Particularly, the lack of supporting infrastructure for green transportation such as electric vehicle charging stations, emission measurement systems, or modern transit logistics centers makes enterprises unable to implement comprehensive solutions, notwithstanding their wishes.

Infrastructure often requires investment at the macro level, requires coordination between central, local governments and the private sector under the PPP (Public Private Partnership) model. This will create a foundation for sustainable and synchronous development of green logistics.

Supportive Policies need to Go Beyond Mere Orientation

Although "supportive policies" factor has a positive effect ($\beta = 0.187$), the assessment score from the enterprises is the lowest among the five factors (3.64 points). Moreover, the results in Table 3 show the very limited accessibility of enterprises to current policies (only 6.3% of enterprises accessing support for green infrastructure investment, 12.5% of enterprises accessing environmental tax incentives). This reflects a remarkable gap between policies and practical implementation.

This result is completely consistent with the warnings in previous industry reports and studies (Nguyen Thi Huong, 2023) about the lack of specific financial mechanisms, cumbersome procedures and lack of policy

communication. While Vietnam is pursuing the goal of net zero emissions by 2050, it is urgent to reform the policy framework on green logistics in a practical, transparent and easily accessible.

CONCLUSION

In the context of a strong global shift towards sustainable development, green logistics is no longer a voluntary choice but an inevitable requirement for Vietnamese enterprises if they want to maintain their competitiveness and international integration. By measuring and analyzing five groups of factors, including awareness of the environment, technological capability, financial capacity, technical infrastructure and supportive policies, the study has indicated the specific impact of each factor on the implementation of green logistics in enterprises.

The results show that top management's awareness and commitments are key factors in initiating the transformation. However, factors such as financial capacity, quality of technical infrastructure and efficiency of government's supportive policies play a supporting role as necessary conditions that determine the ability to realize green goals. Especially, the rate of access to supportive policies is still very limited, showing a remarkable gap between policy orientation and practical application in enterprises.

From the results of analysis and synthesis, the study gives a number of recommendations to promote the implementation of green logistics in Vietnamese enterprises, specifically:

1. Strengthen communications and training on awareness of the environment, especially among small and medium enterprises, which often faces obstacles in terms of information and resources, to raise their awareness and commitments to the implementation of environmentally friendly logistics solutions.
2. Enhance support for technology transfer and digital transformation in accordance with the capacity of domestic logistics enterprises. This requires active participation of state management agencies, science and technology organizations and international partners in consulting, training and providing suitable green technology.
3. Reform green financial mechanisms with a focus on simplified procedures, expanded accessibility to preferential credit sources and increased public investment in the development of green logistics infrastructure. This is a key factor to help enterprises overcome barriers in terms of capital in implementing green innovation solutions.
4. Establish an inter-sectoral and inter-regional coordination mechanism to create a synchronous and sustainable green logistics ecosystem. The connection among economic sectors, localities and stakeholders will create a spillover effect that increases the efficiency of policies and innovative activities towards sustainable development of the logistics industry.

This study is expected to make a practical contribution to the policy-making process and provide a practical foundation for enterprises in developing their roadmaps for logistics transformation in the green - smart - sustainable direction to realize the goal of net zero emissions by 2050, which cannot be achieved without an effective and comprehensive green logistics ecosystem in Vietnam.

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