

# Factors Influencing Green Logistics Adoption Intentions among Small and Medium Enterprises (SMEs) in Vietnam: An Empirical Study Based on the TOE Framework

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## ABSTRACT

In an era of global environmental volatility, transitioning to sustainable practices has become a strategic imperative for Small and Medium Enterprises (SMEs) within the global value chain. This study investigates the factors influencing green logistics adoption intentions among SMEs in Vietnam by integrating the Technology-Organization-Environment (TOE) framework. Data were collected through a quantitative survey of 367 managers and owners of Vietnamese SMEs and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4. The empirical results indicate that all seven proposed hypotheses are supported. Notably, top management support and regulatory pressure emerged as the most significant predictors of adoption intention. Furthermore, while relative advantage and compatibility positively influence adoption, technological complexity remains a critical barrier. Market pressure and the quality of green human resources also play vital roles in driving the green transition. Theoretically, this research extends the applicability of the TOE framework to the SME context in an emerging market. Practically, the findings offer evidence-based insights for policymakers to design targeted support mechanisms and for SME managers to strategically align their operations with international environmental standards.

**Keywords:** Green Logistics, SMEs, TOE Framework, Vietnam, Adoption Intention

## 1. INTRODUCTION

In the contemporary era of global environmental volatility, the logistics industry has been identified as a primary contributor to greenhouse gas emissions, necessitating a fundamental shift toward sustainable practices (McKinnon, 2018). Green logistics, which integrates ecological management into traditional supply chain functions, has evolved from a niche concept to a critical component of global trade competitiveness (Sarkis et al., 2011). As international markets increasingly demand transparency in carbon footprints and environmental accountability, the adoption of green initiatives is no longer a voluntary corporate social responsibility gesture but a strategic prerequisite for long-term survival in the global value chain. The transition to green logistics, therefore, represents a dual challenge of optimizing operational efficiency while minimizing the ecological footprint (Zhu et al., 2008).

Vietnam, as a burgeoning manufacturing hub in Southeast Asia, has demonstrated a strong political commitment to transitioning toward a sustainable economy, notably through its pledge to achieve net-zero emissions by 2050 at the COP26 summit. Small and Medium Enterprises (SMEs) constitute the backbone of the Vietnamese economy, accounting for approximately 98% of total businesses and contributing significantly to national employment and GDP (General Statistics Office, 2023). However, the "green transition" presents a profound paradox for these firms. While SMEs are essential for achieving national sustainability goals, they often struggle with a lack of financial resilience, limited technical expertise, and fragmented infrastructure compared to their larger multinational counterparts (Nguyen et al., 2020). This vulnerability makes the adoption of green logistics in the SME sector a complex and multifaceted process that requires deeper academic scrutiny.

Despite the growing body of literature on sustainable supply chain management, empirical evidence regarding the specific drivers of green logistics adoption within the SME sector of developing nations remains fragmented (Zhu et al., 2013). Most existing studies have concentrated on developed economies or large-scale enterprises, often overlooking the unique organizational and environmental contexts that govern SME decision-making in emerging markets. This research gap is particularly evident in Vietnam, where the interplay between rapid industrialization and environmental regulation creates a unique set of pressures for small-scale operators. Consequently, there is an urgent need for a comprehensive study that explores how these firms navigate the barriers to and motivations for adopting green logistics practices.

To address this complexity, the Technology-Organization-Environment (TOE) framework, originally proposed by Tornatzky and Fleischer (1990), provides a robust theoretical lens for analyzing the multifaceted nature of organizational innovation adoption. By categorizing determinants into technological readiness, internal organizational characteristics, and external environmental influences, the TOE framework allows for a holistic examination of how Vietnamese SMEs perceive the benefits and risks of green logistics. Previous research has validated the framework's efficacy in explaining the adoption of complex environmental technologies and sustainable innovations across various industrial sectors (Lin & Ho, 2011; Baker, 2011). By applying this framework, researchers can better understand how factors such as relative advantage, top management support, and regulatory pressure interact to shape adoption intentions.

In light of these considerations, this study aims to investigate the factors influencing green logistics adoption intentions among Vietnamese SMEs by synthesizing the TOE framework within the specific socio-economic landscape of an emerging market. By identifying the critical technological, organizational, and environmental drivers, this research seeks to provide dual contributions. Theoretically, it enriches the literature on sustainable logistics and extends the applicability of the TOE framework to the SME context in a developing nation. Practically, it offers evidence-based insights for policymakers to design targeted support mechanisms and for SME managers to strategically align their operations with global environmental standards, thereby fostering a sustainable competitive advantage in an increasingly green global economy.

## 2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

### 2.1 The TOE Framework and Green Logistics Adoption

The Technology-Organization-Environment (TOE) framework has been widely recognized as a comprehensive baseline for understanding the adoption of organizational innovations (Tornatzky & Fleischer, 1990). Unlike individual-level models such as the Technology Acceptance Model (TAM), the TOE framework accounts for the multifaceted nature of corporate decision-making by synthesizing internal capabilities with external pressures. In the context of green logistics, adoption is not merely a technical upgrade but a strategic transformation that requires the alignment of technological readiness, organizational commitment, and environmental incentives (Lin & Ho, 2011). For Vietnamese SMEs, this framework is particularly salient as it captures the tension between limited internal resources and the growing external mandate for sustainability.

### 2.2 Technological Context and Hypotheses

The technological dimension refers to the characteristics of the green logistics practices available to the firm and their perceived utility. Relative advantage, defined as the degree to which an innovation is perceived as better than the idea it supersedes, remains a primary driver of adoption (Rogers, 2003). When SMEs perceive that green logistics—such as route

optimization or eco-friendly packaging—can lead to long-term cost savings and enhanced brand reputation, their intention to adopt increases (Zhu et al., 2013). Conversely, complexity acts as a significant barrier; if green practices are perceived as difficult to understand or integrate into existing systems, SMEs may hesitate due to the risk of operational disruption. Furthermore, compatibility with existing workflows ensures a smoother transition, reducing the perceived risk of failure. Therefore, it is hypothesized that:

**H1:** Relative advantage has a positive effect on the intention to adopt green logistics.

**H2:** Complexity has a negative effect on the intention to adopt green logistics.

**H3:** Compatibility has a positive effect on the intention to adopt green logistics.

### 2.3 Organizational Context and Hypotheses

Organizational factors describe the internal characteristics of the firm that facilitate or hinder innovation. Among these, top management support is arguably the most critical for SMEs, where decision-making is often centralized. Leaders who prioritize environmental sustainability are more likely to allocate the necessary financial and human resources to "green" their supply chains (Li, 2020). Additionally, the presence of green human resource management practices ensures that employees possess the skills and motivation required to execute eco-friendly logistics strategies. For Vietnamese SMEs, where financial liquidity is often constrained, the availability of internal resources specifically earmarked for sustainability projects significantly lowers the threshold for adoption. Therefore, it is hypothesized that:

**H4:** Top management support significantly promotes the intention to adopt green logistics.

**H5:** Quality of green human resources positively influences adoption intentions.

### 2.4 Environmental Context and Hypotheses

The environmental context focuses on the external arena in which a firm conducts its business. Regulatory pressure from the Vietnamese government, including stricter emission standards and green credit policies, acts as a coercive force driving SMEs toward compliance (Nguyen et al., 2020). Simultaneously, market pressure, stemming from the demands of international partners and environmentally conscious consumers, creates a competitive incentive for "going green." In a globalized economy, SMEs that fail to adopt green logistics risk being excluded from the supply chains of multinational corporations (MNCs) that have strict environmental mandates. Based on these dynamics, I propose:

**H6:** Regulatory pressure has a positive effect on the intention to adopt green logistics.

**H7:** Market pressure has a positive effect on the intention to adopt green logistics.

Based on the theoretical synthesis and the hypotheses developed in the preceding sections, the conceptual framework for this study is illustrated in Figure 1.

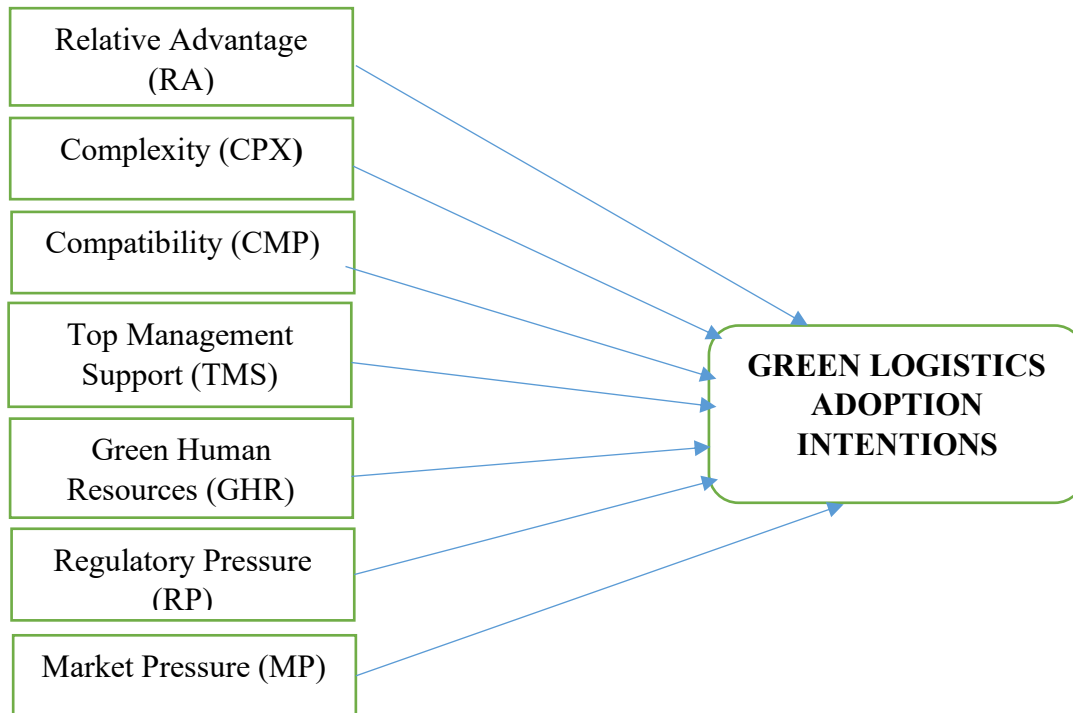


Figure 1: Conceptual framework

### 3. RESEARCH METHODS

#### 3.1. Sample and Data Collection

This study employs a quantitative research approach to validate the hypotheses derived from the TOE framework. The data collection was conducted via an online survey using Google Forms, targeting managers and owners of Small and Medium Enterprises (SMEs) in Vietnam. A total of 367 valid responses were collected. The sample size is deemed sufficient for Partial Least Squares Structural Equation Modeling (PLS-SEM), exceeding the minimum requirements for statistical power. All measurement items utilized a 5-point Likert scale, ranging from "Strongly Disagree" (1) to "Strongly Agree" (5).

#### 3.2. Measurement Scales

The constructs in this study were operationalized using scales adapted from previous empirical research to ensure reliability and validity. The details of the constructs, their definitions, and sources are summarized in Table 1.

Table 1. Summary of Measurement Scales and Construct Definitions

Construct	Definition/Content	Items	Source(s)
<b>Relative Advantage (RA)</b>	The degree to which green logistics practices are perceived as providing better economic and operational benefits than traditional methods.	4	Lin & Ho (2011)
<b>Complexity (CPX)</b>	The degree to which green logistics adoption is perceived as relatively difficult to understand and implement.	3	Lin & Ho (2011)
<b>Compatibility (CMP)</b>	The degree to which green logistics is perceived as being consistent with the existing values, past experiences, and needs of the SME.	3	Lin & Ho (2011)

<b>Top Management Support (TMS)</b>	The extent to which senior executives understand the importance of green initiatives and provide necessary resources for implementation.	4	Nguyen et al. (2024)
<b>Green Human Resources (GHR)</b>	The firm's practices in developing environmental awareness, skills, and motivations among employees through training and management.	4	Jabbour (2011)
<b>Regulatory Pressure (RP)</b>	The influence exerted by government regulations, environmental policies, and legal requirements on the firm.	4	Zhu et al. (2013)
<b>Market Pressure (MP)</b>	The external pressure from customers, competitors, and international partners to adopt sustainable practices.	4	Zhu et al. (2013)
<b>Adoption Intention (AI)</b>	The firm's willingness and strategic plan to implement green logistics practices in its upcoming operations.	3	Lin & Ho (2011)

### 3.3. Data Analysis Method

The conceptual model was analyzed using SmartPLS 4, applying the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. This method was chosen for its capability to handle complex models with multiple paths and its flexibility regarding data distribution assumptions.

The analysis involves two primary stages:

**Measurement Model Evaluation:** To test internal consistency (Cronbach's Alpha and Composite Reliability), convergent validity (Average Variance Extracted - AVE), and discriminant validity (HTMT ratio and Fornell-Larcker criterion).

**Structural Model Evaluation:** To test the hypotheses (H1 to H7) by examining the path coefficients ( $\beta$ ) and the significance levels using the bootstrapping procedure (5,000 sub-samples). The model's explanatory power and predictive relevance are assessed via  $R^2$  and  $Q^2$  values.

## 4. RESULTS AND DISCUSSION

### 4.1. Respondent Profile

The study successfully collected 367 valid responses from managers and owners of SMEs in Vietnam. As illustrated in Table 2, the sample encompasses a diverse range of industries, with the manufacturing sector representing the largest proportion (38.7%), followed by trading (34.1%) and services/logistics (27.2%). In terms of enterprise size, small firms (10-200 employees) constitute the majority of the sample at 58.6%. The demographic distribution of respondents - primarily department managers (50.1%) and owners (25.9%) - ensures that the data reflects strategic organizational perspectives on green logistics adoption.

**Table 2. Profile of Participating SMEs (n = 367)**

Characteristics	Category	Frequency	Percentage (%)
Industry Sector	Manufacturing	142	38.7
	Trading and Commerce	125	34.1
	Services and Logistics	100	27.2
Enterprise Size	Micro (Under 10 employees)	88	24.0
	Small (10 - 200 employees)	215	58.6
	Medium (201 - 300 employees)	64	17.4
Respondent Position	Owner/Director	95	25.9
	Department Manager	184	50.1
	Logistics/Sustainability Officer	88	24.0

#### 4.2. Measurement Model Evaluation

The measurement model was assessed for reliability and validity. According to the results in Table 3, all outer loadings for the indicators range from 0.758 to 0.921, exceeding the recommended threshold of 0.708. Construct reliability is confirmed as Cronbach's Alpha (0.712 to 0.872) and Composite Reliability ( $\rho_c$ ) (0.838 to 0.912) for all constructs are well above the 0.70 limit. Convergent validity is also established, with the Average Variance Extracted (AVE) for each construct exceeding the 0.50 benchmark, ranging from 0.633 to 0.726. Furthermore, collinearity is not a concern as all Variance Inflation Factor (VIF) values for the indicators are below 3.0, specifically between 1.322 and 2.521.

**Table 3. Reliability and Convergent Validity Results**

Construct	Items	Loadings	VIF	Cronbach's Alpha	$\rho_c$ (CR)	AVE
Adoption Intention (AI)	AI1 - AI3	0.758 - 0.863	1.322 - 1.530	0.712	0.838	0.633
Compatibility (CMP)	CMP1 - CMP3	0.794 - 0.867	1.517 - 1.696	0.777	0.870	0.691
Complexity (CPX)	CPX1 - CPX3	0.811 - 0.921	1.708 - 1.926	0.820	0.888	0.726
Green Human Resource (GHR)	GHR1 - GHR4	0.820 - 0.880	1.824 - 2.521	0.872	0.912	0.721
Market Pressure (MP)	MP1 - MP4	0.809 - 0.856	1.882 - 2.014	0.850	0.899	0.689
Relative Advantage (RA)	RA1 - RA4	0.781 - 0.832	1.552 - 1.965	0.825	0.884	0.656
Regulatory Pressure (RP)	RP1 - RP4	0.791 - 0.854	1.744 - 2.141	0.852	0.900	0.692
Top Mgmt Support (TMS)	TMS1 - TMS4	0.761 - 0.859	1.628 - 2.019	0.840	0.893	0.675

Discriminant validity was verified using both the Fornell-Larcker criterion and the HTMT ratio, as presented in Table 4. The square root of the AVE for each construct (shown on the diagonal) is greater than its correlations with other constructs. Additionally, all HTMT ratios are below the 0.85 threshold, with the highest value being 0.430, confirming that each

**Table 4. Discriminant Validity: Fornell-Larcker and HTMT**

Construct	AI	CMP	CPX	GHR	MP	RA	RP	TMS
AI	<b>0.796</b>	0.275	0.125	0.292	0.354	0.430	0.386	0.424
CMP	0.211	<b>0.832</b>	0.031	0.088	0.049	0.048	0.042	0.064
CPX	-0.107	-0.008	<b>0.852</b>	0.087	0.098	0.054	0.136	0.059
GHR	0.233	0.073	0.073	<b>0.849</b>	0.066	0.124	0.054	0.047
MP	0.284	-0.026	0.075	0.052	<b>0.830</b>	0.084	0.096	0.060
RA	0.335	0.023	-0.005	0.107	0.064	<b>0.810</b>	0.063	0.053
RP	0.308	-0.014	0.107	0.007	0.051	0.049	<b>0.832</b>	0.061
TMS	0.334	0.021	-0.032	-0.017	0.047	0.041	0.044	<b>0.822</b>

Note: Values on the diagonal (bold) are the square root of AVE; values above the diagonal are HTMT ratios.

### 4.3. Structural Model Evaluation and Hypothesis Testing

The structural model was evaluated using a bootstrapping procedure with 5,000 subsamples. Table 5 details the hypothesis testing results. All seven hypotheses are supported at the  $p < 0.05$  level. Notably, Top Management Support ( $\beta = 0.293, p = 0.000$ ) and Regulatory Pressure ( $\beta = 0.288, p = 0.000$ ) emerged as the strongest predictors of Adoption Intention. Complexity ( $\beta = -0.158, p = 0.003$ ) has a significant negative impact, as hypothesized.

**Table 5. Path Coefficients and Hypothesis Testing**

Hypothesis	Relationship	Path Coeff. (O)	T Statistics	P Values	Result
H1	Relative Advantage -> AI	0.268	6.797	0.000	Supported
H2	Complexity -> AI	-0.158	2.998	0.003	Supported
H3	Compatibility -> AI	0.193	5.626	0.000	Supported
H4	Top Management Support -> AI	0.293	8.377	0.000	Supported
H5	Green Human Resources -> AI	0.192	5.167	0.000	Supported
H6	Regulatory Pressure -> AI	0.288	7.422	0.000	Supported
H7	Market Pressure -> AI	0.245	5.955	0.000	Supported

As shown in Table 6, the model explains 44.8% of the variance in Adoption Intention ( $R^2 = 0.448$ ). The effect sizes ( $f^2$ ) indicate that TMS (0.154) and RP (0.147) have medium impacts, while other factors have small impacts on the dependent variable. Finally, the  $Q^2$ predict value of 0.414 confirms the model's strong predictive relevance.

**Table 6. Predictive Power and Effect Sizes**

Construct	R-square	$Q^2$ predict	Predictors	f-square	Effect Size
Adoption Intention	0.448	0.414	Top Mgmt Support	0.154	Medium
			Regulatory Pressure	0.147	Medium
			Relative Advantage	0.127	Medium
			Market Pressure	0.107	Small
			Compatibility	0.067	Small
			Green Human Resource	0.065	Small
			Complexity	0.044	Small

#### 4.4 Discussion

The empirical findings of this study confirm that all seven proposed hypotheses are statistically significant, validating the robustness of the Technology-Organization-Environment (TOE) framework in explaining green logistics adoption intentions among SMEs in Vietnam. Notably, Top Management Support (TMS) ( $\beta = 0.293$ ,  $p < 0.001$ ) and Regulatory Pressure (RP) ( $\beta = 0.288$ ,  $p < 0.001$ ) emerged as the most influential determinants of this strategic decision. This reflects the unique characteristics of the Vietnamese economic landscape, where SMEs often operate under centralized management structures and are heavily influenced by government policy directions. These results align with the findings of Li (2020) and Abdul-Rashid et al. (2017), who argued that in small-scale enterprises, the vision and commitment of top executives are the primary "keys" to mobilizing resources for environmental initiatives. Furthermore, as Vietnam actively pursues its Net-zero commitment by 2050, legal pressures - such as the Law on Environmental Protection 2020 - have transformed from mere compliance burdens into powerful coercive drivers. This forces firms to adapt to survive, echoing the observations of Zhu et al. (2013) regarding the pivotal role of institutional pressure in emerging markets.

Regarding the technological dimension, Relative Advantage (RA) ( $\beta = 0.268$ ) and Compatibility (CMP) ( $\beta = 0.193$ ) exert significant positive effects, while Complexity (CPX) ( $\beta = -0.158$ ) acts as a critical barrier. These results substantiate Rogers' (2003) Diffusion of Innovation (DOI) theory, suggesting that Vietnamese SMEs are only willing to transition when they perceive long-term economic value, such as operational cost optimization through energy efficiency or enhanced brand reputation. The positive impact of compatibility indicates that enterprises prioritize green solutions that can be seamlessly integrated into existing workflows without causing major disruptions. Conversely, the negative path coefficient of complexity warns that technical hurdles and a lack of specialized expertise in sustainable logistics remain significant deterrents for managers. This reinforces the findings of Lin and Ho (2011) in their study on green innovation in the logistics industry, emphasizing that simpler and more accessible technological solutions are more likely to be accepted by SMEs.

Furthermore, Market Pressure (MP) ( $\beta = 0.245$ ) and the quality of Green Human Resources (GHR) ( $\beta = 0.192$ ) play vital roles in accelerating the transition. In an increasingly integrated economy, Vietnamese SMEs often serve as links in the global supply chains of multinational corporations (MNCs). Consequently, demands for "clean logistics" from international partners and competitors create an irreversible market force, a phenomenon also documented by Nguyen et al. (2021) in developing nations. Simultaneously, the study demonstrates that when a firm possesses a workforce with high environmental awareness and skills, the intention to adopt green logistics increases. This underscores the importance of Green Human Resource Management as a necessary condition for executing sustainable strategies, mirroring Jabbour's (2011) arguments regarding the link between human capital and eco-efficiency. In summary, the multifaceted interaction between internal organizational capabilities, technological characteristics, and external environmental pressures forms a comprehensive roadmap for the shift toward green logistics among Vietnamese SMEs.

#### 5. CONCLUSION

This study conducted an empirical analysis of the factors influencing the intention to adopt green logistics among small and medium enterprises (SMEs) in Vietnam, grounded in the Technology-Organization-Environment (TOE) framework. Through a survey of 367 enterprises and the application of PLS-SEM, the research validated the conceptual model as all seven proposed hypotheses were supported. The findings indicate that the intention to transition toward sustainable logistics among Vietnamese SMEs is most strongly driven by top

management support and regulatory pressure, while technological complexity remains a significant barrier for decision-makers.

In terms of theoretical implications, this research contributes to the literature on sustainable supply chain management by extending the applicability of the TOE framework to the specific context of developing nations. In such environments, SMEs serve as the backbone of the economy but frequently face severe resource constraints. The results affirm that green logistics adoption is not merely a technical decision but a multidimensional process resulting from the interaction between internal organizational capabilities and external coercive pressures.

Regarding managerial implications, the study offers practical recommendations for both corporate managers and policymakers. For enterprise management, raising leadership awareness and investing in green human resource training are strategic steps to transform sustainable logistics into a competitive advantage. Businesses should prioritize green solutions that demonstrate high compatibility with existing systems to mitigate risks associated with technological complexity. For the government, refining the legal framework for green development and establishing financial and technical support mechanisms for SMEs are essential to accelerate the roadmap toward achieving the Net-zero commitment by 2050.

Despite achieving significant results, this study is subject to certain limitations. First, the data were collected at a single point in time (cross-sectional), which does not capture changes in behavioral intentions over time. Second, the geographical focus on the Vietnamese market may limit the generalizability of the findings to countries with different socio-economic backgrounds. Therefore, future research could consider conducting cross-country comparative analyses or employing longitudinal data to provide deeper insights into the green transition process within the global logistics industry.

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