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Drivers of Green Logistics Implementation and Firm Performance: Evidence from Vietnam's Logistics Sector

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ABSTRACT

This study investigates the determinants of green logistics implementation and firm performance in Vietnam's freight forwarding industry. Drawing on the Resource-Based View and Institutional Theory, the research examines how green technological capability, environmental orientation, environmental pressure, green collaboration, and firm scale influence green logistics practices and subsequent performance outcomes. Survey data were collected from 286 respondents in logistics firms operating in Vietnam. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to test the proposed framework. The results indicate that green technological capability and firm scale significantly enhance green logistics implementation. Environmental orientation also exerts a positive effect on both green logistics implementation and firm performance. In contrast, environmental pressure does not directly influence green logistics implementation but significantly drives green collaboration. Green collaboration, however, does not directly improve firm performance. Green logistics implementation significantly improves firm performance and mediates the effects of environmental orientation, firm scale, and technological capability on performance. These findings extend sustainable supply chain management literature by clarifying the relative importance of internal capabilities, organizational characteristics, and institutional drivers in an emerging market context. The study demonstrates that internal strategic orientation and operational capabilities are more influential than external pressures in promoting effective green logistics implementation. Managerially, the results suggest that logistics firms should prioritize capability development and strategic environmental commitment to enhance performance outcomes. Policymakers can support sustainability transitions by strengthening institutional frameworks while facilitating capability building among logistics firms.

Keywords: *Green Logistics Implementation, Environmental Orientation, Technological Capability, Logistics Service Providers, Firm Performance, Sustainable Logistics, Emerging Economy*

1. INTRODUCTION

The logistics sector plays a central role in global supply chains and faces growing pressure to reduce environmental impacts resulting from freight transportation and operational inefficiencies (Rondinelli & Berry, 2000). Although green logistics practices—such as emission reduction, energy-efficient technologies, and sustainable packaging—have been widely promoted as pathways to mitigate logistics-related environmental impacts (Varghese & Pradhan, 2025; Samper *et al.,* 2022), their adoption remains uneven across industries and regions. Prior studies attribute these differences to variations in technological readiness, regulatory environments, and firm-level capabilities (Gerlitz & Meyer, 2021; Yan *et al.,* 2022). These disparities highlight the need for deeper insight into the mechanisms that drive or hinder the adoption of green logistics practices in specific segments of the logistics industry (An *et al.,* 2024). However, from an operations and supply chain management perspective, green logistics adoption is not merely a sustainability initiative but an operational design and coordination challenge embedded within inter-firm logistics networks (Creazza *et al.,* 2023).

Freight forwarding firms represent a particularly important yet underexamined segment for sustainability transitions (Saithalavi & Soman, 2025). Unlike manufacturers or asset-heavy logistics providers, freight forwarders must coordinate dispersed actors and multimodal flows while operating under tight cost, time, and capacity constraints (Alavi-Borazjani *et al.,* 2025). As logistics intermediaries, freight forwarders function as network orchestrators rather than asset owners, relying heavily on external carriers, warehouse operators, and transport partners to execute distribution activities (Zacharia *et al.,* 2011). Moreover, many Vietnamese freight forwarders operate under asset-light models, outsourcing trucking and warehousing to third-party providers. This outsourcing-intensive structure shifts the locus of operational control outside the firm, making environmental performance contingent upon coordination mechanisms, information sharing, and contractual alignment across the supply chain (Bu *et al.,* 2020). These operational complexities create distinct barriers to implementing green routing, modal shifts, and environmentally efficient transport consolidation (Shah *et al.,* 2025). Accordingly, green logistics implementation in freight forwarding contexts becomes a problem of inter-organizational integration and supply chain alignment rather than solely an internal strategic decision.

Vietnam provides a highly relevant boundary condition for examining these mechanisms. The logistics sector is expanding rapidly, supporting strong economic growth, yet it faces significant environmental challenges associated with emissions, congestion, and infrastructure bottlenecks (Phung *et al.,* 2022). Although the government has articulated ambitious sustainability targets, the implementation of green logistics practices—particularly among freight forwarding firms—remains limited (Binh *et al.,* 2024). Several practical barriers shape this context. The trucking fleet is highly fragmented, with more than 90% of operators classified as micro or small enterprises, making the standardization of green practices difficult. Such structural fragmentation increases coordination costs, limits visibility across transport flows, and complicates the enforcement of sustainability standards within supply networks (de Jesus *et al.,* 2025). Together, Vietnam's freight forwarding sector operates within a fragmented logistics structure dominated by small trucking providers, inconsistent regulatory enforcement, and limited capital for technology upgrades. These characteristics make Vietnam an analytically relevant setting for examining how supply chain structure influences green logistics implementation at the intermediary level.

Green logistics adoption is shaped by a combination of internal organizational capabilities and external institutional pressures. Drawing on the Resource-Based View (RBV), internal factors such as financial resources, technological readiness, and managerial expertise influence a firm's ability to implement sustainability-oriented logistics solutions (Barney, 2021). At the same time, Institutional Theory highlights how coercive regulations, normative expectations, and market pressures—such as requirements from multinational clients to report emissions or use sustainable packaging—drive firms toward environmentally responsible practices (Chen *et al.,* 2023). Within freight forwarding, however, these drivers operate through operational coordination mechanisms, as firms must translate capability endowments and institutional demands into executable logistics routines across outsourced partners (Özcan *et al.,* 2023). Together, these perspectives offer a lens for understanding how firm-level capabilities and external pressures shape operational decisions regarding green logistics implementation.

Despite growing interest in green logistics, several important operational and managerial gaps remain insufficiently addressed. First, the freight forwarding sector has received limited scholarly attention despite its unique operational uncertainties and dependence on third-party logistics partners. Second, prior studies often conceptualize adoption as a firm-level strategic outcome without explicitly considering the networked execution processes required in outsourced logistics systems. This overlooks the operational reality that sustainability initiatives in freight forwarding depend on supply chain collaboration, coordination intensity, and integration capabilities. Third, evidence from emerging markets such as Vietnam remains scarce, and adoption mechanisms cannot simply be transferred from developed economies due to fragmented logistics networks, capital constraints, and uneven regulatory enforcement.

Accordingly, this study investigates how internal capabilities and external pressures translate into green logistics implementation within an intermediary supply chain structure. It addresses the following research questions:

(1) How are green logistics practices operationally configured across transportation, warehousing, and coordination activities within Vietnam's freight forwarding supply networks?

(2) How do internal coordination capabilities and external institutional conditions influence the effectiveness of these operational configurations?

This study makes three key contributions. First, it contributes to the operations and supply chain management literature by reconceptualizing green logistics implementation as a coordination-intensive process embedded in outsourced logistics networks rather than solely as a strategic sustainability choice. Second, it offers empirical evidence from an emerging-market logistics environment characterized by structural fragmentation and intermediary dependence. Third, it provides actionable insights for freight forwarders and supply chain partners regarding operational alignment, collaboration design, and integration mechanisms necessary for implementing environmentally sustainable logistics practices.

2. LITERATURE REVIEW

2.1 *Green Logistics as an Operational Configuration Challenge*

Green logistics refers to the incorporation of environmentally responsible practices into logistics operations in order to reduce emissions and improve resource efficiency (Centobelli *et al.,* 2020). Within freight transportation systems, environmental performance is closely tied to routing decisions, modal selection, load consolidation, and coordination efficiency across supply chain actors (International Energy Agency, 2024). Rather than being purely a sustainability initiative, green logistics increasingly represents an operational configuration problem involving trade-offs among cost, time, flexibility, and environmental impact (Ferdous, 2025).

In the freight forwarding sector, these trade-offs are particularly pronounced (Akbar *et al.,* 2020). Freight forwarders function primarily as coordinators of transportation flows rather than asset owners (Heinbach *et al.,* 2022). Their performance depends on synchronizing carriers, port operators, customs brokers, and warehouse providers across multimodal networks (Phung *et al.,* 2022). As a result, implementing green logistics practices—such as modal shifts, fuel-efficient routing, digital tracking, or emissions monitoring—requires alignment not only within the firm but also across multiple external partners (Nagy & Szentesi, 2024).

This networked structure introduces operational constraints that differ substantially from manufacturing or vertically integrated logistics settings (Lee *et al.,* 2023). Because many freight forwarders operate under asset-light models, their ability to implement green transport solutions depends on the technological and environmental capabilities of subcontracted carriers and logistics partners (Sales & Scholte, 2023). Consequently, green logistics adoption in freight forwarding is shaped by coordination capability, inter-organizational collaboration, and access to operational technologies rather than by environmental intent alone (Bag *et al.,* 2022).

While prior research documents environmental and reputational benefits associated with green logistics practices (Allen *et al.,* 2021; Chen, Lee, *et al.,* 2023), fewer studies examine how operational dependencies and network structures condition firms' ability to implement such practices (Lee *et al.,* 2023). This gap is particularly relevant in emerging markets, where logistics networks are often fragmented and characterized by heterogeneous partner capabilities.

2.2 Capability Constraints and Institutional Pressures in Emerging Logistics Networks

Sustainable Supply Chain Management (SSCM) research emphasizes the integration of environmental objectives into logistics and supply chain processes (Razzak, 2022). In operational contexts, this integration often involves digitalization, data visibility, collaborative planning, and process redesign (An *et al.,* 2021). Technologies such as IoT-enabled tracking systems and digital logistics platforms enhance route efficiency, reduce idle time, and support emissions monitoring (Centobelli *et al.,* 2020). However, the effectiveness of such practices depends on firms' technological readiness and coordination capacity.

From a Resource-Based View perspective, organizational capabilities—including technological access, financial flexibility, and managerial expertise—enable firms to reconfigure logistics processes toward sustainability-oriented objectives. Yet in intermediary contexts such as freight forwarding, capability development must extend beyond internal resources to include relational coordination and information-sharing mechanisms with external partners.

At the same time, Institutional Theory suggests that regulatory mandates, customer requirements, and industry norms exert external pressure on firms to align operations with environmental standards (Chen *et al.,* 2023). In emerging markets, institutional enforcement may be uneven, creating variability in how strongly firms perceive and respond to sustainability demands (Huq & Stevenson, 2018).

Vietnam represents a particularly instructive environment for examining these mechanisms (Do *et al.,* 2024). Its logistics sector is characterized by fragmented trucking markets, limited digital integration, and capital constraints among small service providers (Leung *et al.,* 2023). Under such conditions, the interaction between internal capabilities and external pressures may not produce straightforward adoption outcomes. Instead, operational decisions related to green logistics are likely to reflect negotiation between resource constraints, coordination feasibility, and institutional expectations (Baah *et al.,* 2020).

Despite growing research on SSCM and green logistics, limited empirical evidence explains how firm-level capabilities and external pressures jointly shape operational decision-making within freight forwarding networks in emerging economies (Hien & Nguyen , 2023). Furthermore, less attention has been given to how these mechanisms interact rather than operate independently. Addressing this gap is essential for understanding not only whether firms adopt green logistics practices, but how structural and institutional conditions shape those decisions.

3. THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

3.1 Theoretical Framework

This study draws on the Resource-Based View (RBV) and Institutional Theory to examine the adoption of green logistics practices among freight forwarding firms in Vietnam. RBV emphasizes the role of internal capabilities and strategic resources, while Institutional Theory stresses the influence of regulatory, normative, and competitive pressures. Together, these perspectives offer a structured explanation of how both internal and external forces shape sustainability decisions in the logistics sector.

3.1.1 Resource-Based View (RBV)

The Resource-Based View (RBV) argues that competitive advantage originates from resources that are valuable, rare, inimitable, and non-substitutable (Barney & Arikan, 2005; Barney, 2021). In the context of green logistics, such resources include digital routing and tracking systems, eco-friendly vehicle fleets, renewable energy infrastructure, and environmental management expertise (Chen *et al.,* 2023). Firms possessing these strategic assets are better positioned to reduce emissions, improve operational efficiency, and implement green logistics practices in a systematic and effective manner (Tetteh *et al.,* 2024).

RBV also emphasizes that resources alone are insufficient. Their value is realized only when firms develop complementary organizational capabilities. Capabilities such as digital readiness, environmental training programs, cross-functional coordination, and continuous improvement systems determine whether green technologies are successfully integrated into logistics operations (Centobelli *et al.,* 2020). These capabilities allow firms to convert technological investments into operational benefits, environmental improvements, and strategic advantage (Ouni & Abdallah, 2024).

RBV is particularly relevant to Vietnam's freight forwarding industry, where technological adoption remains uneven and many firms operate with limited financial and managerial capacity. As the sector is dominated by SMEs, capability deficiencies—such as lack of digital skills, limited absorptive capacity, and weak innovation routines—often hinder the effective implementation of green technologies. Therefore, RBV helps explain heterogeneity in green logistics adoption across Vietnamese freight forwarding firms.

3.1.2 Institutional Theory

Institutional Theory highlights how external pressures—regulatory mandates, industry norms, and competitive expectations—shape organizational behavior and influence firms' sustainability decisions (Zucker, 1987; Chu *et al.,* 2018; Zhu *et al.,* 2021). These pressures operate through three primary mechanisms: coercive forces stemming from government regulations and environmental policies; normative forces emerging from professional associations, stakeholder expectations, and global supply chain requirements; and mimetic forces that lead firms to model themselves after successful competitors when facing uncertainty (Kauppi & Hannibal, 2017). In the logistics sector, these institutional mechanisms are known to influence the adoption of environmental management systems, green logistics technologies, and sustainability-oriented operational routines (Chen *et al.,* 2023; Duzgun & Atay, 2025).

In Vietnam, however, the institutional landscape presents unique characteristics that make institutional pressures particularly complex (Duzgun *et al.,* 2024). Although the Vietnamese government has introduced ambitious sustainability frameworks—such as the National Green Growth Strategy, environmental protection laws, and emission-reduction targets—their implementation remains inconsistent across provinces and industry segments (Do *et al.,* 2024). This creates what many scholars describe as institutional voids, where formal policies exist, but enforcement mechanisms, administrative capacity, and monitoring systems are weak or unpredictable. Consequently, coercive pressures appear strong in policy documents but remain weak in practical enforcement, which reduces firms' incentives to fully comply with sustainability regulations.

Normative and mimetic pressures in Vietnam also differ from those in more advanced institutional environments. Normative pressures often originate not from domestic industry associations—whose sustainability standards remain underdeveloped—but from multinational clients, foreign-invested logistics companies, and international supply chain partners who increasingly demand greener operations. Mimetic pressures are particularly visible in major logistics hubs such as Ho Chi Minh City and Hai Phong, where local firms tend to imitate green practices introduced by global logistics players like DHL, Maersk, or DB Schenker to enhance legitimacy and maintain competitiveness. However, in regions farther from major ports, such pressures remain comparatively weak.

Adding further complexity, the logistics sector in Vietnam is dominated by small and medium-sized enterprises (SMEs) that often lack the managerial expertise, technological readiness, and financial resources required to respond effectively to institutional pressures (Duzgun *et al.,* 2024). These firms tend to adopt symbolic sustainability actions—such as public statements or minimal compliance—rather than substantive environmental changes. Thus, the interaction between limited internal capabilities and inconsistent external pressures creates a fragmented landscape in which the adoption of green logistics practices varies significantly across firms.

These conditions make Vietnam a theoretically meaningful context for applying Institutional Theory. The coexistence of strong policy ambitions and weak enforcement, the uneven distribution of normative and mimetic pressures, and the dominance of resource-constrained SMEs offer a distinctive institutional setting where firms must actively interpret and negotiate conflicting pressures. Understanding how freight forwarding companies respond to these mixed signals is crucial for explaining the drivers and barriers of green logistics adoption in emerging economies. This context therefore provides valuable insights into how institutional forces interact with organizational capabilities in shaping sustainable logistics transitions. This theoretical perspective directly informs the development of hypotheses related to environmental pressure and collaborative responses in Section 3.2.

3.2 Hypotheses Development

Drawing on the Resource-Based View (RBV) and Institutional Theory, this study develops a framework explaining how internal capabilities, institutional pressures, organizational characteristics, and collaborative mechanisms jointly shape green logistics implementation and firm performance in freight forwarding networks (Shibin *et al.,* 2020).

From an RBV perspective, Green Technological Capability (GTC) represents a strategic organizational resource that enables firms to improve operational efficiency and enhance competitive positioning (Waqas *et al.,* 2024). Green technological capability encompasses the ability to access, integrate, and utilize environmentally supportive technologies such as digital routing systems, emissions monitoring tools, fuel-efficient transport solutions, and logistics information platforms (Nwaichi *et al.,* 2025). These technologies enhance visibility, reduce operational inefficiencies, and support environmentally informed decision-making. In emerging logistics markets such as Vietnam, technological capability often reflects broader organizational sophistication and process formalization. Firms that successfully deploy green technologies typically develop stronger coordination routines, data-driven planning systems, and structured operational procedures. Such improvements may contribute not only to environmental performance but also to organizational growth and expansion of operational scope. Accordingly, green technological capability may strengthen firm scale by enhancing service reliability, increasing efficiency, and enabling market development. By improving operational efficiency, reducing coordination costs, and enhancing service differentiation, green technological capability may allow firms to expand their customer base and operational scope over time, thereby contributing to organizational growth.

H1: Green Technological Capability positively influences Firm Scale.

Beyond its potential impact on organizational growth, green technological capability directly facilitates the operational implementation of sustainability practices (Baah *et al.,* 2020). RBV suggests that resources create value when they are embedded into organizational routines and transformed into operational capabilities (Barney, 2021). In freight forwarding systems—where coordination across carriers, ports, and warehouses is critical—green technologies enable route optimization, emissions tracking, load consolidation, and real-time information sharing. Firms with stronger green technological capability are therefore better positioned to integrate environmental considerations into transportation planning and logistics coordination, leading to more systematic implementation of green logistics practices (Centobelli *et al.,* 2020).

H2: Green Technological Capability positively influences Green Logistics Implementation.

Institutional Theory emphasizes that organizational practices are shaped by external pressures arising from regulatory requirements, stakeholder expectations, and competitive dynamics (Zhu *et al.,* 2021). Environmental Pressure (EP) may originate from government environmental regulations, customer sustainability demands, international supply chain standards, and competitive imitation (Dai *et al.,* 2015). Even in contexts characterized by uneven regulatory enforcement, increasing integration into global markets exposes firms to sustainability expectations from multinational clients and international logistics partners. To maintain legitimacy, secure contracts, and enhance competitive positioning, firms may respond by adopting environmentally responsible logistics practices (Baah *et al.,* 2020). In Vietnam's freight forwarding sector, where exposure to global trade is high, environmental pressure may therefore serve as a significant driver of green logistics implementation.

H3: Environmental Pressure positively influences Green Logistics Implementation.

Environmental pressure may also influence firms indirectly by encouraging collaborative responses (Dai *et al.,* 2015). When sustainability expectations intensify, firms often rely on supply chain partners to share knowledge, coordinate compliance efforts, and jointly implement environmentally responsible initiatives. In asset-light freight forwarding systems, where operational execution depends heavily on subcontracted carriers and logistics partners, collaborative coordination becomes essential for meeting institutional demands (Wagner & Klein, 2021). Green Collaboration (GC), defined as joint environmental planning, information sharing, and coordinated sustainability initiatives across supply chain actors, may thus be strengthened in response to environmental pressure.

H4: Environmental Pressure positively influences Green Collaboration.

In addition to external pressure, internal strategic orientation plays a crucial role in shaping sustainability decisions (Zailani *et al.,* 2012). Environmental Orientation (EO) reflects a firm's managerial commitment to environmental responsibility and its proactive stance toward sustainability integration. Firms with strong environmental orientation are more likely to interpret external pressures as strategic opportunities rather than compliance burdens (Nazir *et al.,* 2024). Such firms may actively seek partnerships aligned with environmental objectives and allocate resources toward sustainability initiatives (Ko *et al.,* 2021). Consequently, environmental orientation may enhance collaborative sustainability efforts within logistics networks.

H5: Environmental Orientation positively influences Green Collaboration.

Environmental orientation may also directly influence the extent to which firms embed environmental considerations into operational processes (El-Garaihy *et al.,* 2022). A proactive sustainability mindset can shape strategic priorities, investment decisions, and performance evaluation criteria, thereby facilitating the integration of green logistics practices into transportation, warehousing, and coordination activities.

H6: Environmental Orientation positively influences Green Logistics Implementation.

Within fragmented freight forwarding networks, collaboration functions as a coordination mechanism that reduces operational silos and enhances the diffusion of sustainable practices (Vargas *et al.,* 2018). Through joint planning, shared information systems, and coordinated environmental initiatives, green collaboration can mitigate resource constraints and improve implementation feasibility. Such collaborative arrangements may strengthen the effectiveness and scope of green logistics implementation across interconnected actors.

H7: Green Collaboration positively influences Green Logistics Implementation.

Organizational characteristics may further condition sustainability outcomes (Bask & Rajahonka, 2017). Firm Scale (FS), reflecting organizational size and operational scope, may influence resource availability, managerial capacity, and process formalization. Larger firms typically possess greater financial flexibility, structured governance systems, and stronger bargaining power, which may facilitate the integration of green logistics practices into operational routines (Yang *et al.,* 2015).

H8: Firm Scale positively influences Green Logistics Implementation.

Beyond implementation, sustainability-related capabilities and structural characteristics may influence performance outcomes (Ortiz-Avram *et al.,* 2023). Green collaboration may enhance operational efficiency and innovation through coordinated environmental initiatives. Environmental orientation may strengthen corporate reputation and attract sustainability-conscious clients. Firm scale may provide economies of scale and cost advantages that improve competitive positioning.

H9: Green Collaboration positively influences Firm Performance.

H10: Environmental Orientation positively influences Firm Performance.

H11: Firm Scale positively influences Firm Performance.

Finally, Green Logistics Implementation (GLI) represents the operational embedding of environmentally responsible practices into logistics processes. Effective implementation may reduce fuel consumption, enhance route efficiency, improve service reliability, and strengthen stakeholder relationships (Fan *et al.,* 2023). Although initial implementation may involve adjustment costs, green logistics practices are expected to enhance firm performance over time through operational efficiencies and strategic differentiation (Famiyeh *et al.,* 2018).

H12: Green Logistics Implementation positively influences Firm Performance.

In addition to direct effects, the proposed relationships suggest indirect pathways through which environmental pressure and environmental orientation influence green logistics implementation and firm performance via collaborative mechanisms and organizational scale. These interconnected relationships reflect the dynamic interaction between internal capabilities and external institutional conditions in shaping sustainable logistics outcomes. Collectively, the proposed model integrates Green Technological Capability (GTC), Environmental Pressure (EP), Environmental Orientation (EO), Firm Scale (FS), and Green Collaboration (GC) as key antecedents of Green Logistics Implementation (GLI) and Firm Performance (FP). By combining the Resource-Based View and Institutional Theory, the framework explains how organizational resources, external pressures, and relational coordination mechanisms jointly influence sustainable logistics transitions within emerging freight forwarding networks. The conceptual framework is presented in Figure 1.

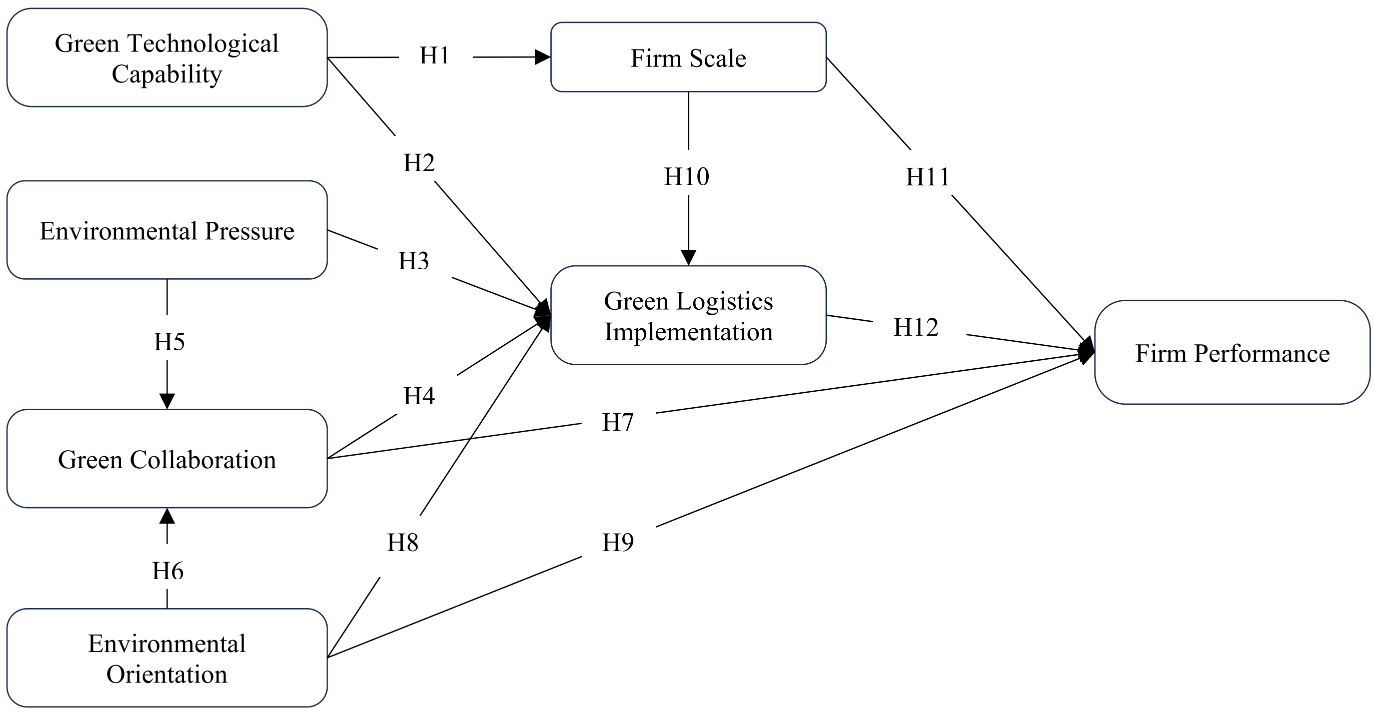

Figure 1 Conceptual Research Model.

4. METHODOLOGY

4.1 Research Design and Data Collection

This study adopts a quantitative research design to examine the determinants of green logistics implementation and firm performance within Vietnam's freight forwarding sector. A cross-sectional survey method was employed to collect primary data from logistics professionals actively engaged in freight forwarding operations. The choice of a survey-based design is appropriate given the study's objective to empirically test theoretically derived hypotheses and assess relationships among multiple latent constructs within a structural framework.

The target population comprises freight forwarding firms operating in major logistics hubs in Vietnam, including Ho Chi Minh City, Hanoi, and Hai Phong. These firms function within intermediary and asset-light supply chain structures, coordinating transportation, warehousing, and international shipment services through subcontracted carriers and network partners. Given the sector's fragmentation and the dominance of small and medium-sized enterprises, data were collected from respondents occupying operational, managerial, and executive roles to ensure informed assessments of organizational capabilities and environmental practices.

A structured questionnaire was developed and distributed both electronically and in person. Respondents were required to have a minimum of one year of experience in the logistics sector to ensure familiarity with their firm's operational and environmental activities. A total of 312 questionnaires were returned. After eliminating incomplete responses and observations exhibiting response bias patterns, 286 valid responses were retained for analysis, resulting in a final sample size of N = 286. This sample size exceeds the minimum sample requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM) and provides adequate statistical power for testing the proposed structural model.

Data were collected between July 2024 and October 2024 using a combination of purposive and snowball sampling techniques. Initial contacts were established through professional networks, including LinkedIn, company mailing lists, Zalo, and WhatsApp groups related to the logistics sector. Participants were encouraged to share the survey with qualified colleagues within their firms, facilitating broader organizational coverage. To reduce single-informant bias and enhance data reliability, we requested that each participating firm provide responses from multiple managerial employees (a minimum of four to five respondents per firm where possible). This multi-respondent strategy helps mitigate individual response bias and provides a more reliable assessment of firm-level practices. The questionnaire was administered via Google Forms, allowing efficient distribution and response monitoring.

The demographic profile of respondents is presented in Table 1. The sample consists predominantly of male respondents (70.6%), while 29.4% are female. In terms of experience, 38.8% had between 0–2 years of experience, 50.7% had 3–5 years, 2.4% had 6–10 years, and 8.0% had more than 10 years. Regarding organizational position, 41.3% were junior staff, 40.9% were mid-level managers, 12.2% were senior managers, and 5.6% were executives. The majority of respondents held a bachelor's degree (90.2%), while 7.0% possessed a master's degree and 2.8% held a

Table 1 Demographic Profiles of Respondents (N = 286)

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Male	202	70.6
	Female	84	29.4
Experience	0–2 years	111	38.8
	3–5 years	145	50.7
	6–10 years	7	2.4
	More than 10 years	23	8.0
Position	Junior staff	118	41.3
	Mid-level management	117	40.9
	Senior management	35	12.2
	Executive	16	5.6
Education	Bachelor's degree	258	90.2
	Master's degree	20	7.0
	PhD	8	2.8

doctoral qualification. These characteristics suggest that the sample represents a professionally engaged workforce with relevant operational knowledge of freight forwarding activities.

The unit of analysis in this study is the individual respondent. Although multiple responses were obtained from the same firm, the constructs were measured at the perceptual level and reflect individual managerial assessments of organizational practices. Therefore, the structural model examines relationships among individual-level perceptions rather than firm-level aggregated measures. Given the study's theoretical focus and the use of PLS-SEM with bootstrapping procedures, the analysis was conducted at the individual level.

4.2 *Measurement Development*

All constructs were measured using multi-item scales adapted from previously validated studies to ensure content validity and theoretical consistency. Some measurement items were adapted and reworded from prior validated instruments to ensure contextual suitability. Minor wording modifications were made to reflect the specific characteristics of Vietnam's freight forwarding industry while preserving the original conceptual meaning of each construct. The questionnaire was originally developed in English and subjected to expert review to ensure clarity, contextual appropriateness, and content validity prior to distribution.

The study operationalizes seven latent constructs: Green Technological Capability, Environmental Pressure, Environmental Orientation, Green Collaboration, Firm Scale, Green Logistics Implementation, and Firm Performance. All perceptual constructs were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). This scale format is widely used in sustainability and logistics research and is appropriate for capturing managerial perceptions in emerging market contexts.

Green Technological Capability reflects the firm's ability to access, integrate, and effectively utilize environmentally supportive technologies, including digital routing systems, emissions monitoring tools, and logistics information platforms. Environmental Pressure captures perceived regulatory, normative, and competitive pressures related to sustainability. Environmental Orientation measures managerial commitment and proactive organizational attitudes toward environmental responsibility. Green Collaboration assesses joint environmental planning, knowledge sharing, and coordinated sustainability initiatives with supply chain partners. Firm Scale reflects organizational size and operational scope and was measured using categorical indicators of employee headcount and annual revenue, which were treated as ordinal variables in the structural model. Green Logistics Implementation represents the extent to which environmental considerations are embedded in logistics planning and operational routines. Firm Performance was measured using subjective performance indicators relative to competitors, including operational efficiency, market competitiveness, and service quality.

To enhance clarity and ensure contextual relevance, the questionnaire was pre-tested with academic experts and logistics professionals prior to full deployment. Feedback from the pilot stage resulted in minor wording adjustments to improve comprehensibility without altering the theoretical structure of the constructs.

4.3 *Data Analysis Procedure*

Descriptive statistical analysis of demographic characteristics was conducted using SPSS version 28. Structural model estimation was performed using SmartPLS 3.

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) (Kumar *et al.,* 2023). PLS-SEM is particularly suitable for this study for several reasons. First, the research aims to explain variance in green logistics implementation and firm performance within an emerging market context. Second, the proposed framework includes multiple latent constructs and indirect relationships, requiring a method capable of estimating complex structural paths. Third, PLS-SEM is appropriate for prediction-oriented research and theory development, particularly when distributional assumptions may not be strictly satisfied and when the primary objective is variance explanation rather than model fit confirmation.

Table 2 Measurement Model Assessment.

Variables Threshold	Loadings ≥0.6	Alpha ≥0.7	rho_A ≥0.7	CR ≥0.7	AVE ≥0.5
Green Technological Capability (GTC)		0.833	0.838	0.900	0.750
GTC1	0.840				
GTC2	0.888				
GTC3	0.870				
Environmental Pressure (EP)		0.911	0.913	0.945	0.850
EP1	0.948				
EP2	0.937				
EP3	0.880				
Green Collaboration (GC)		0.902	0.907	0.939	0.836
GC1	0.934				
GC2	0.933				
GC3	0.876				
Green Logistics Implementation (GLI)		0.920	0.921	0.949	0.862
GLI1	0.927				
GLI2	0.942				
GLI3	0.917				
Firm Performance (FP)		0.868	0.869	0.919	0.791
FP1	0.894				
FP2	0.903				
FP3	0.872				
Firm Scale (FS)		0.840	0.846	0.926	0.861
FS1	0.936				
FS2	0.920				
Environmental Orientation (EO)		0.789	0.790	0.877	0.703
EO1	0.829				
EO2	0.845				
EO3	0.842				

Note(s): All outer loadings exceed 0.60. Cronbach's alpha, rho_A, and composite reliability (CR) values are above the recommended threshold of 0.70, and average variance extracted (AVE) values exceed 0.50, indicating satisfactory internal consistency reliability and convergent validity.

The analysis followed a two-stage approach. In the first stage, the measurement model was evaluated to assess reliability and validity (Rafiq *et al.,* 2020). Internal consistency reliability was examined using Cronbach's alpha and composite reliability values, with thresholds exceeding 0.70 indicating acceptable reliability. Convergent validity was assessed through indicator loadings and average variance extracted (AVE), where loadings above 0.70 and AVE values above 0.50 were considered satisfactory (Cheung *et al.,* 2023). Discriminant validity was evaluated using the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio to ensure adequate construct distinctiveness (Dirgiatmo, 2023).

In the second stage, the structural model was assessed by examining path coefficients, coefficients of determination (R^2), effect sizes (f^2), and predictive relevance (Q^2). Bootstrapping with 5,000 resamples was employed to test the statistical significance of both direct and indirect effects, providing robust standard errors and confidence intervals. Multicollinearity among predictor constructs was evaluated using variance inflation factor (VIF) values, with all VIF values below the recommended threshold of 5, indicating that collinearity did not bias parameter estimates.

Given that data were collected using a single self-reported survey instrument, both procedural and statistical remedies were implemented to mitigate potential common method bias. Procedurally, respondents were assured of anonymity and confidentiality, and questionnaire items were carefully structured to reduce response pattern bias and social desirability effects. Statistically, Harman's single-factor test was conducted using unrotated principal component analysis. The results indicated that the first factor accounted for 30.457% of the total variance, which is below the commonly accepted 50% threshold. This finding suggests that common method variance is unlikely to pose a serious threat to the validity of the study's results.

Table 3 Discriminant Validity – Fornell–Larcker Criterion.

	EO	EP	FP	FS	GC	GLI	GTC
EO	**0.839**						
EP	0.123	**0.922**					
FP	0.295	0.119	**0.890**				
FS	0.188	0.112	0.282	**0.928**			
GC	0.145	0.705	0.084	0.146	**0.914**		
GLI	0.427	0.204	0.454	0.390	0.166	**0.928**	
GTC	0.324	0.227	0.312	0.190	0.186	0.422	**0.866**

Note: Diagonal elements (in bold) represent the square root of the average variance extracted (AVE). Each construct's square root of AVE exceeds its correlations with other constructs, satisfying the Fornell–Larcker criterion.

Table 4 Discriminant Validity – HTMT Ratio.

	EO	EP	FP	FS	GC	GLI	GTC
EO							
EP	0.144						
FP	0.356	0.134					
FS	0.226	0.127	0.329				
GC	0.175	0.775	0.096	0.169			
GLI	0.499	0.222	0.506	0.443	0.183		
GTC	0.401	0.262	0.365	0.226	0.217	0.481	

Note: HTMT values below 0.85 indicate satisfactory discriminant validity. All values are below the recommended threshold, confirming construct distinctiveness.

Table 5 Collinearity Assessment (Inner VIF Values).

	EO	EP	FP	FS	GC	GLI	GTC
EO			1.232		1.015	1.145	
EP					1.015	2.027	
FP							
FS			1.189			1.069	
GC			1.044			2.016	
GLI			1.401				
GTC				1.000		1.182	

Note: All inner VIF values are below the conservative threshold of 3.3, indicating that multicollinearity is not a concern.

5. RESULTS

5.1 Measurement Model Assessment

The measurement model was evaluated to assess internal consistency reliability, convergent validity, and discriminant validity. Table 2 reports the indicator loadings, Cronbach's alpha, rho_A, composite reliability (CR), and average variance extracted (AVE) for all constructs. All indicator loadings exceed the recommended threshold of 0.70, demonstrating strong item reliability. Cronbach's alpha values range from 0.789 to 0.920, while composite reliability values range from 0.877 to 0.949, exceeding the recommended cutoff of 0.70. Furthermore, AVE values range between 0.703 and 0.862, all above the minimum threshold of 0.50. These results confirm satisfactory internal consistency and convergent validity.

Discriminant validity was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio. As shown in Table 3, the square root of AVE for each construct exceeds its correlations with other constructs, satisfying the Fornell–Larcker criterion. Although the correlation between Environmental Pressure and Green Collaboration is relatively high, the square roots of their AVE values (0.922 and 0.914, respectively) remain greater than the inter-construct correlation, supporting discriminant validity.

In addition, HTMT values were examined as a more stringent test of discriminant validity. As reported in Table 4, all HTMT values are below the conservative threshold of 0.85, further confirming adequate construct distinctiveness.

Table 6 Model Fit Assessment.

Fit Index	Estimated Model
SRMR	0.059
NFI	0.790

Note: SRMR values below 0.08 indicate acceptable model fit.

Table 7 Coefficient of Determination (R^2).

	R Square	R Square Adjusted
Firm Performance	0.231	0.220
Firm Scale	0.036	0.033
Green Collaboration	0.501	0.497
Green Logistics Implementation	0.355	0.344

Note: R^2 values indicate the proportion of variance explained in each endogenous construct. According to commonly accepted benchmarks in PLS-SEM (0.75 = substantial, 0.50 = moderate, 0.25 = weak), Green Collaboration demonstrates moderate explanatory power, Green Logistics Implementation and Firm Performance exhibit weak-to-moderate explanatory power, and Firm Scale shows weak explanatory power.

Table 8 Predictive Relevance (Q^2) Results.

Endogenous Construct	SSO	SSE	Q^2
Firm Performance	858.000	711.829	0.170
Firm Scale	572.000	555.813	0.028
Green Collaboration	858.000	508.577	0.407
Green Logistics Implementation	858.000	604.306	0.296

Note: Q^2 values greater than zero indicate predictive relevance.

Table 9 Effect Size (f^2).

	EO	EP	FP	FS	GC	GLI	GTC
EO			0.016		0.007	0.108	
EP					0.960	0.008	
FP							
FS			0.016			0.115	
GC			0.000			0.001	
GLI			0.118				
GTC				0.038		0.089	

5.2 Structural Model Assessment

Before evaluating the structural relationships, multicollinearity was assessed using inner variance inflation factor (VIF) values. As shown in Table 5, all VIF values range between 1.000 and 2.027, well below the conservative threshold of 3.3, indicating that collinearity does not pose a concern in the model.

Model fit was assessed using the standardized root mean square residual (SRMR) and the normed fit index (NFI). As reported in Table 6, the SRMR value is 0.059, which is below the recommended threshold of 0.08, indicating acceptable model fit. The NFI value of 0.790 suggests an adequate incremental fit for a variance-based SEM model.

The explanatory power of the model was evaluated using the coefficient of determination (R^2). As shown in Table 7, the model explains 50.1% of the variance in Green Collaboration, 35.5% in Green Logistics Implementation, 23.1% in Firm Performance, and 3.6% in Firm Scale. These values indicate moderate explanatory power for the main endogenous constructs.

Predictive relevance was assessed using Stone–Geisser's Q^2 values obtained through blindfolding. As presented in Table 8, all endogenous constructs exhibit Q^2 values greater than zero, confirming the model's predictive relevance. Green Collaboration (Q^2 = 0.407) and Green Logistics Implementation (Q^2 = 0.296) demonstrate particularly strong predictive capability.

Effect sizes (f^2) were examined to assess the substantive impact of exogenous constructs on endogenous variables. As shown in Table 9, Environmental Pressure exhibits a large effect on Green Collaboration (f^2 = 0.960), while Green Logistics Implementation demonstrates a moderate effect on Firm Performance (f^2 = 0.118). Other relationships show small to moderate effect sizes, indicating varying magnitudes of influence across structural paths.

Table 10 Structural Model Path Coefficients.

Hypothesis	Path	β (O)	STDEV	T-Value	P-Value	Result
H1	GTC → FS	0.190	0.068	2.815	0.005	Supported
H2	GTC → GLI	0.261	0.065	4.026	< 0.001	Supported
H3	EP → GLI	0.105	0.070	1.508	0.132	Not Supported
H4	GC → GLI	-0.038	0.068	0.563	0.574	Not Supported
H5	EP → GC	0.698	0.043	16.052	< 0.001	Supported
H6	EO → GC	0.060	0.037	1.592	0.112	Not Supported
H7	GC → FP	-0.011	0.048	0.231	0.817	Not Supported
H8	EO → GLI	0.283	0.063	4.459	< 0.001	Supported
H9	EO → FP	0.121	0.059	2.054	0.040	Supported
H10	FS → GLI	0.281	0.064	4.384	< 0.001	Supported
H11	FS → FP	0.122	0.057	2.138	0.033	Supported
H12	GLI → FP	0.356	0.078	4.561	< 0.001	Supported

Note: β = standardized path coefficient; STDEV = standard deviation; significance assessed using bootstrapping with 5,000 resamples; two-tailed test.

Table 11 Mediation Analysis – Indirect Effects.

Path	β (Indirect)	T-Value	P-Value	Decision
EO → GLI → FP	0.101	3.209	0.001	Significant
FS → GLI → FP	0.100	2.805	0.005	Significant
GTC → GLI → FP	0.093	2.813	0.005	Significant

Note: Indirect effects were assessed using bootstrapping with 5,000 resamples (two-tailed). β represents standardized indirect effects.

5.3 Hypothesis Testing (Path Coefficients)

The structural model was evaluated by examining the significance and strength of the hypothesized relationships using bootstrapping with 5,000 resamples. Path coefficients (β), standard errors, t-values, and p-values were assessed to determine hypothesis support. The results indicate that green technological capability (GTC) has a significant positive effect on firm scale (FS) (β = 0.190, p = 0.005), supporting H1. GTC also positively influences green logistics implementation (GLI) (β = 0.261, p < 0.001), supporting H2. However, environmental pressure (EP) does not significantly affect GLI (β = 0.105, p = 0.132), leading to the rejection of H3. Similarly, green collaboration (GC) does not have a significant impact on GLI (β = –0.038, p = 0.574), and thus H4 is not supported.

The results further reveal that EP has a strong positive effect on GC (β = 0.698, p < 0.001), providing strong support for H5. In contrast, environmental orientation (EO) does not significantly influence GC (β = 0.060, p = 0.112), leading to the rejection of H6. Additionally, GC does not significantly affect firm performance (FP) (β = –0.011, p = 0.817), and therefore H7 is not supported.

Regarding the remaining hypotheses, EO positively affects GLI (β = 0.283, p < 0.001), supporting H8, and also has a direct positive effect on FP (β = 0.121, p = 0.040), supporting H9. Firm scale (FS) significantly influences GLI (β = 0.281, p < 0.001) and FP (β = 0.122, p = 0.033), supporting H10 and H11, respectively. Finally, GLI exerts a significant positive effect on FP (β = 0.356, p < 0.001), providing support for H12.

In addition to the direct effects, mediation relationships were examined to assess indirect influences on firm performance. The results show that GLI significantly mediates the relationship between EO and FP (β = 0.101, p = 0.001), as well as between FS and FP (β = 0.100, p = 0.005), and between GTC and FP (β = 0.093, p = 0.005). These findings indicate that green logistics implementation serves as an important transmission mechanism linking organizational and technological capabilities to firm performance.

6. DISCUSSION

6.1 Overview of Key Findings

This study examined the structural relationships among green technological capability, environmental pressure, environmental orientation, firm scale, green collaboration, green logistics implementation, and firm performance. The results provide several important insights.

First, green technological capability positively influences both firm scale and green logistics implementation, highlighting its strategic role in enabling firms to expand and operationalize environmentally sustainable logistics practices(Agyabeng-Mensah *et al.,* 2020). Environmental orientation significantly enhances green logistics implementation and directly improves firm performance (Bu *et al.,* 2020). Firm scale also demonstrates a positive effect on both green logistics implementation and firm performance. Moreover, green logistics implementation exerts a strong positive effect on firm performance, confirming its central mediating role within the model.

Environmental pressure strongly drives green collaboration; however, neither environmental pressure nor green collaboration directly improves firm performance or green logistics implementation (Yang, 2018). Importantly, the mediation analysis shows that environmental orientation, firm scale, and green technological capability indirectly enhance firm performance through green logistics implementation. These findings collectively underscore the pivotal role of green logistics implementation as a mechanism translating strategic orientation and technological capability into performance outcomes.

6.2 Theoretical Implications

This study contributes to the sustainability and operations management literature in several ways. First, drawing on the natural resource-based view (NRBV), the findings reinforce the argument that internal capabilities—particularly green technological capability—serve as strategic resources that generate competitive advantage when embedded in operational processes (Hart, 1995). The positive link between green technological capability and green logistics implementation confirms that technological competence facilitates the adoption of environmentally responsible logistics practices (Liu *et al.,* 2024).

Second, the significant relationship between environmental orientation and both green logistics implementation and firm performance extends prior research suggesting that strategic environmental commitment shapes organizational behavior and performance outcomes (Zhou *et al.,* 2019). This supports the argument that proactive environmental orientation is not merely symbolic but translates into operational improvements and tangible performance gains.

Third, the mediating role of green logistics implementation advances the understanding of how sustainability-oriented resources are transformed into economic outcomes (Nicoletti & Appolloni, 2024). Rather than exerting purely direct effects, strategic capabilities appear to operate through operational mechanisms. This finding aligns with process-based perspectives in operations management, which emphasize that performance benefits emerge through effective implementation rather than through strategic intent alone.

Fourth, the non-significant direct effects of environmental pressure and green collaboration on firm performance challenge assumptions in institutional theory that external pressure alone guarantees performance improvements (DiMaggio & Powell, 1983). Instead, external pressures may stimulate compliance behaviors (e.g., collaboration), but without effective operational integration, these efforts may not directly enhance financial or operational outcomes.

Overall, the study refines the theoretical understanding of how internal capabilities, external pressures, and operational practices interact to shape firm performance in environmentally sustainable contexts.

6.3 Practical Implications

The findings offer several important managerial implications. First, managers should prioritize the development of green technological capability, as it supports both firm expansion and effective green logistics implementation. Investments in eco-efficient technologies, digital systems, and process innovations are not only environmentally beneficial but strategically valuable. Second, cultivating a strong environmental orientation at the strategic level is critical. Firms that embed environmental values into corporate strategy are more likely to implement green logistics practices successfully and achieve superior performance outcomes. Third, while environmental pressure encourages collaboration, managers should avoid relying solely on compliance-driven initiatives. Collaborative efforts must be integrated into core operational systems to generate measurable performance benefits. Fourth, firm scale positively influences both green logistics implementation and performance, suggesting that growing firms should strategically leverage their scale advantages to institutionalize sustainability practices.

For policymakers, the findings indicate that regulatory pressure alone may not guarantee improved firm performance. Complementary mechanisms—such as technological support programs or green capability development initiatives—may be necessary to translate environmental compliance into economic gains.

6.4 Unexpected Findings

Several findings warrant deeper contextual interpretation, particularly considering the structural and institutional characteristics of the Vietnamese freight forwarding sector. Contrary to expectations, environmental pressure does not significantly influence green logistics implementation (H3). Institutional theory generally suggests that regulatory and stakeholder pressures encourage firms to adopt environmentally responsible practices (DiMaggio & Powell, 1983). However, the findings indicate that such pressures may not directly translate into operational changes within freight forwarding firms in Vietnam. One important explanation lies in the structural characteristics of the sector. Many freight forwarders operate under asset-light business models, relying heavily on third-party carriers and logistics service providers rather than owning transportation assets themselves. As a result, even when firms experience environmental pressure from regulators or customers, their ability to directly control transportation-related environmental practices—such as vehicle emissions, fuel efficiency, or routing technologies—remains limited. This dependence on external logistics partners weakens the direct influence of environmental pressure on the implementation of green logistics initiatives.

In addition, enforcement gaps and cost pressures in emerging logistics markets may further limit the effectiveness of environmental pressure. Although Vietnam has introduced environmental policies and sustainability initiatives, the intensity of regulatory enforcement and monitoring may vary across industries and regions. Consequently, environmental regulations may raise awareness but may not always generate sufficiently strong coercive pressure to trigger substantial operational investments in green logistics practices. In highly competitive freight forwarding markets characterized by strong price competition and relatively thin margins, firms often prioritize operational efficiency and cost control over sustainability investments that require additional financial resources (Yang, 2018).

Similarly, green collaboration does not significantly influence green logistics implementation (H4) or firm performance (H7). In the Vietnamese freight forwarding context, collaboration among supply chain partners frequently focuses on operational coordination rather than strategic environmental integration. Freight forwarders typically coordinate logistics activities among multiple independent actors, including shipping lines, trucking companies, customs brokers, and warehouse operators. While such coordination is essential for managing shipment flows, these relationships are often transactional and short-term in nature. As a result, collaborative interactions may not necessarily involve joint environmental initiatives, shared sustainability investments, or coordinated green innovation efforts that would meaningfully improve green logistics implementation (Agyabeng-Mensah *et al.,* 2020).

Another unexpected result is that environmental orientation does not significantly influence green collaboration (H6). Although firms may possess internal environmental awareness or managerial commitment to sustainability, this orientation may remain largely internalized within the organization rather than extending into inter-organizational collaboration. Implementing environmental initiatives across supply chains often requires aligned incentives, trust, and shared strategic priorities among multiple actors. In fragmented logistics networks such as freight forwarding systems, firms may face difficulties coordinating environmental objectives across independent partners, which may prevent internal environmental orientation from translating into collaborative sustainability initiatives (Bu *et al.,* 2020).

Finally, the absence of a significant relationship between green collaboration and firm performance (H7) suggests that collaborative environmental initiatives may not yet generate immediate economic benefits in this sector. Environmental collaborations frequently involve additional coordination costs, information sharing challenges, and uncertain financial returns. In developing logistics markets where firms operate under intense competitive pressures, managers may perceive environmental collaboration as an additional operational burden rather than a direct driver of short-term performance improvements (Nicoletti & Appolloni, 2024).

Overall, these findings highlight the importance of contextualizing sustainability practices within the structural and institutional realities of the freight forwarding industry in emerging economies. While institutional pressures and collaborative relationships are often expected to promote environmental transformation, the results suggest that structural industry characteristics and internal organizational capabilities may play a more decisive role in shaping the implementation of green logistics practices in this context.

6.5 Limitations and Future Research

This study has several limitations that provide opportunities for future research. First, the cross-sectional design limits causal inference. Longitudinal studies could better capture the dynamic evolution of green capabilities and performance outcomes. Second, the study relies on perceptual survey data, which may introduce common method bias, although statistical tests suggest this is not a serious concern. Future research could incorporate objective performance measures. Third, the sample is confined to a specific national context. Replication in different institutional environments would enhance generalizability. Comparative studies across developed and emerging economies may reveal how institutional strength moderates the relationships identified in this study. Finally, future research may explore additional mediators or moderators, such as digital transformation, organizational culture, or supply chain complexity, to further clarify the mechanisms linking sustainability-oriented capabilities and firm performance.

7. CONCLUSION

This study investigated the structural relationships among green technological capability, environmental pressure, environmental orientation, firm scale, green collaboration, green logistics implementation, and firm performance within an emerging market context. Using PLS-SEM analysis, the findings demonstrate that green logistics implementation plays a central mediating role in translating internal capabilities and strategic orientation into superior firm performance. In particular, green technological capability, environmental orientation, and firm scale significantly enhance green logistics implementation, which in turn positively affects firm performance. These results highlight that sustainability-driven performance gains do not arise automatically from external pressures or symbolic collaboration but are realized through effective operational integration.

The study makes several important contributions to the sustainability and operations management literature. First, it extends the natural resource-based view by empirically confirming that internal green capabilities must be operationalized through logistics implementation to generate measurable performance outcomes. Second, it clarifies the limited direct role of environmental pressure and green collaboration, suggesting that external forces alone are insufficient to secure competitive advantage without internal strategic commitment and technological readiness. Third, by positioning green logistics implementation as a key mediating mechanism, the study advances understanding of how sustainability strategies are transformed into tangible economic benefits in emerging market settings.

From a managerial perspective, the findings underscore the importance of investing in green technological capability and embedding environmental orientation into corporate strategy. Firms seeking performance improvement should focus not only on regulatory compliance or collaborative signaling but on systematically integrating sustainability into logistics operations. Policymakers, likewise, should complement environmental regulations with programs that support capability development and technological upgrading. Overall, this study reinforces the view that sustainable competitive advantage is achieved through the alignment of strategic intent, technological capability, and operational execution.

CONFLICTS OF INTEREST

The author declares that there is no conflict of interest.

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APPENDIX A. SURVEY MEASUREMENT ITEMS

Construct	Measurement Items	Source
Green Technological Capability (GTC)	GTC1: Our firm is capable of acquiring advanced environmentally friendly logistics technologies. GTC2: The organization allocates resources toward adopting green technological solutions to enhance operational performance. GTC3: Environmentally sustainable technologies form an integral component of our strategic planning.	Bag et al. (2020); Khan et al. (2022)
Environmental Pressure (EP)	EP1: Government regulations encourage our firm to implement environmentally responsible practices. EP2: Customers, investors, and other external stakeholders expect us to improve our environmental performance. EP3: Industry norms and regulatory standards influence our environmental decisions.	Ko et al. (2021); Baah et al. (2020)
Green Collaboration (GC)	GC1: We engage with supply chain partners to enhance environmental sustainability initiatives. GC2: Our firm exchanges sustainability-related knowledge and expertise with business partners. GC3: Environmental objectives are coordinated with key members of our supply chain.	Heydari et al. (2020)
Green Logistics Implementation (GLI)	GLI1: Our logistics activities incorporate environmentally sustainable practices such as low-emission transport and eco-friendly materials. GLI2: Sustainability considerations are embedded in our logistics planning and execution processes. GLI3: We consistently upgrade logistics operations to reduce environmental impact.	Bag et al. (2020); Lee (2021)
Firm Performance (FP)	FP1: The adoption of environmentally sustainable practices has enhanced our operational effectiveness. FP2: Environmental initiatives have contributed positively to our financial outcomes. FP3: Our sustainability efforts have strengthened our corporate image and market reputation.	Lee et al. (2023); Azeem et al. (2024)
Firm Scale (FS)	FS1: Please indicate the approximate number of employees in your organization (1 = Fewer than 50; 2 = 50–100; 3 = 101–500; 4 = 501–1000; 5 = More than 1000). FS2: Please indicate your organization's annual revenue category (1 = Less than $1 million; 2 = $1–10 million; 3 = $10–50 million; 4 = $50–100 million; 5 = More than $100 million).	Sanusi & Johl (2022)
Environmental Orientation (EO)	EO1: Employees within our organization recognize the environmental consequences of business operations. EO2: The company promotes environmentally responsible behavior among staff members. EO3: Environmental responsibility is embedded in the organizational culture across different managerial levels.	Adapted from: Cantor et al. (2012); Zhou et al. (2024)

Note: All perceptual items were measured using a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree).

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