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Twin Transition in Emerging Markets: The Role of Digital Capabilities and Institutional Drivers on Green Innovation in Vietnam's Logistics Sector

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ABSTRACT

This study investigates the antecedents of Green Innovation within the Vietnamese logistics sector by examining the interplay between digital capabilities and institutional drivers under the "Twin Transition" framework. Adopting a Sequential Exploratory Mixed-Methods design, the research integrates the Resource-Based View (RBV) with Institutional Theory to analyze data from 218 logistics managers using Partial Least Squares Structural Equation Modeling (PLS-SEM). The empirical results reveal a distinctive "State-Led Green Innovation" model where Government Support emerges as the paramount driver (beta = 0.677), significantly overshadowing internal factors. While Leadership Commitment proves to be a critical catalyst (beta = 0.179), the study identifies a "Resource Paradox," indicating that Technology Readiness and Financial Resources, though significant, exert a comparatively weak influence without institutional impetus. These findings challenge market-centric innovation narratives, suggesting that for transition economies, policymakers must evolve from subsidy-driven approaches to capacity-building infrastructures, while managers must prioritize strategic alignment with national agendas to foster sustainable transformation.

Keywords: Twin Transition, Green Innovation, Logistics, Resource-Based View, Institutional Theory, Vietnam.

INTRODUCTION

The contemporary global economic landscape is being reshaped by the convergence of two powerful transformative forces: the Fourth Industrial Revolution (Industry 4.0) and the imperative for sustainable development. This synergistic phenomenon, increasingly referred to in academic literature as the "Twin Transition," posits that digital transformation is not merely a tool for operational efficiency but a critical enabler for achieving environmental objectives such as decarbonization and circularity [11]. While digital technologies - ranging from the Internet of Things (IoT) to Big Data Analytics - have been widely recognized for their potential to optimize resource consumption and reduce carbon footprints in developed economies [5], the dynamics of this transition in emerging markets remain complex and under-researched. In these distinct institutional environments, the interplay between technological adoption and green innovation is often complicated by resource constraints, infrastructure deficits, and varying degrees of regulatory pressure [5].

Vietnam serves as a compelling empirical setting to investigate this phenomenon. As one of the most dynamic economies in Southeast Asia, Vietnam’s logistics sector acts as the "artery" of the national economy, sustaining an impressive annual growth rate of 14-16% [18]. The *Agility*

Emerging Markets Logistics Index 2024 ranks Vietnam 8th overall among emerging markets and 4th in terms of international logistics opportunities, highlighting its pivotal role in global supply chains (Agility, 2024) [1]. However, this rapid expansion has engendered a "development paradox": the sector is plagued by systemic inefficiencies, with logistics costs accounting for approximately 16.8% of GDP - significantly higher than the global average of 10-12% [26] - and contributing a substantial share of greenhouse gas emissions due to fragmented transport networks and high empty-running rates.

Despite the Vietnamese government's aggressive promotion of digital agendas, exemplified by *Decision No. 749/QĐ-TTg* approving the "National Digital Transformation Program to 2025" [21], and the increasing adoption of international green standards such as the FIATA digital bill of lading [12], there remains a paucity of empirical evidence regarding the causal mechanisms linking digital capabilities to green outcomes in this context. Existing literature predominantly focuses on developed Western economies or treats digital and green transformations as separate silos, failing to capture the "nexus" effects in transition economies. Critical questions remain unanswered: Does digital readiness automatically translate into green innovation in a resource-constrained environment? To what extent do institutional factors - such as government support and global integration pressures - moderate or drive this relationship?

To bridge this gap, this study draws upon the Resource-Based View (RBV) of the firm to construct a comprehensive theoretical framework [3]. The RBV perspective suggests that for firms to achieve a competitive advantage in the "twin transition," they must orchestrate a unique bundle of internal resources (technological readiness, leadership commitment) and external enablers (government support, financial access) [13]. The primary objective of this paper is to empirically examine the impact of these five critical antecedents on Green Innovation (GI) within the Vietnamese logistics industry.

This study makes several contributions to the literature. First, it extends the discourse on the "Twin Transition" by providing rare empirical evidence from an emerging market, moving beyond the theoretical abstractions often found in prior studies. Second, by utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) on a dataset of 218 logistics managers, it quantifies the relative weight of institutional versus technological drivers, offering a nuanced understanding of what truly propels green innovation in a state-guided market economy. Finally, the findings offer actionable insights for policymakers and practitioners aiming to decouple economic growth from environmental degradation in the logistics sector.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Theoretical Underpinnings: The Resource-Based View (RBV)

This study grounds its theoretical framework in the Resource-Based View (RBV), a dominant paradigm in strategic management which posits that a firm's sustainable competitive advantage is derived from its unique bundle of internal resources and capabilities that are valuable, rare, inimitable, and non-substitutable [3, 25]. In the context of the modern logistics industry, the definition of "strategic resources" has undergone a fundamental shift. Traditional physical assets, such as warehouses and vehicle fleets, are increasingly becoming commoditized, while intangible assets - specifically "Digital Assets" like big data analytics, Internet of Things (IoT) infrastructure, and artificial intelligence algorithms - are emerging as the new drivers of differentiation.

Furthermore, the integration of these digital resources with environmental objectives gives rise to "Green Dynamic Capabilities" [6; 23]. This concept extends the RBV by suggesting that mere possession of resources is insufficient; rather, firms must possess the dynamic capability to reconfigure their internal competencies to address rapidly changing external environmental constraints. In this study, we argue that digital transformation provides the necessary informational infrastructure that enables logistics firms to build these green dynamic capabilities, thereby facilitating the adoption of green innovations such as dematerialization and energy optimization.

Hypothesis Development

Technology Readiness (TR) and Green Innovation:

Technology Readiness (TR) refers to an organization's propensity to embrace and utilize new technologies to accomplish its goals [19]. In the logistics sector, TR is manifested through the adoption of advanced digital infrastructure, including cloud computing, IoT sensors, and blockchain-enabled tracking systems. Empirical literature suggests that a high level of technology readiness is a critical antecedent to green innovation because it provides the granular data necessary for environmental decision-making [5]. For instance, IoT-enabled fleet management systems allow for real-time monitoring of fuel consumption and route efficiency, directly facilitating the reduction of carbon emissions. Without a robust technological foundation, firms lack the visibility required to identify and eliminate inefficiencies in their supply chain, rendering green initiatives theoretical rather than practical.

- H1: Technology Readiness has a positive impact on Green Innovation.

Global Integration Pressure (GIP) and Green Innovation:

Drawing from Institutional Theory, organizations are not autonomous entities but are deeply embedded in a social structure where they seek legitimacy and survival by conforming to the rules and norms of their institutional environment [9]. For logistics firms operating in emerging markets like Vietnam, this pressure is predominantly "coercive" and originates from global supply chain partners. As multinational corporations increasingly commit to Net Zero targets, they exert significant pressure on their downstream logistics providers to adopt similar environmental standards, such as the FIATA eFBL (digital bill of lading) or strict ESG reporting (Zhu & Sarkis, 2007). Consequently, the drive for green innovation in these firms is often an isomorphic response to the demands of global integration rather than a purely internal strategic choice.

- H2: Global Integration Pressure has a positive impact on Green Innovation.

Leadership Commitment (LC) and Green Innovation:

While external pressures provide the impetus for change, the internal mobilization of resources requires strong top management support. Leadership commitment is defined as the degree to which upper management perceives environmental sustainability as a strategic priority and is willing to champion these initiatives [10]. The implementation of green innovation is inherently risky and resource-intensive, often requiring long-term return on investment horizons that conflict with short-term financial goals. Therefore, the unwavering support of leadership is essential to overcome internal inertia, foster a pro-environmental organizational culture, and sanction the necessary budgetary allocations for green projects (Zhu & Sarkis, 2007). Without

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this "tone from the top," digital and green initiatives are likely to remain fragmented and superficial.

- H3: Leadership Commitment has a positive impact on Green Innovation.

Government Support (GS) and Green Innovation:

In transition economies, the government plays a more interventionist role than in developed free-market economies, often acting as the primary architect of industrial modernization. Government support manifests through policy frameworks, financial incentives, and regulatory guidance that reduce the costs and risks associated with green transformation [23]. In Vietnam, initiatives such as the "National Digital Transformation Program" (Decision 749/QĐ-TTg) create a favorable institutional environment that encourages firms to digitize [21]. By providing tax breaks, green credit packages, or subsidized training programs, the government essentially subsidizes the "learning cost" of adopting new green technologies, making innovation more accessible to domestic firms [2].

- H4: Government Support has a positive impact on Green Innovation.

Financial Resources (FR) and Green Innovation:

Finally, the availability of financial resources acts as a critical enabler for translating strategic intent into operational reality. According to the Theory of Organizational Slack, firms with uncommitted resources (financial slack) are better positioned to experiment with new innovations because they can absorb the potential costs of failure [4]. Green innovation, such as upgrading to electric vehicle fleets or installing automated warehouse systems, requires substantial upfront capital expenditure. This is particularly relevant in the context of Small and Medium Enterprises (SMEs) in the logistics sector, where capital constraints are often cited as the primary barrier to environmental adoption [16]. Therefore, firms with greater financial depth are hypothesized to be more agile in adopting green innovations.

- H5: Financial Resources have a positive impact on Green Innovation.

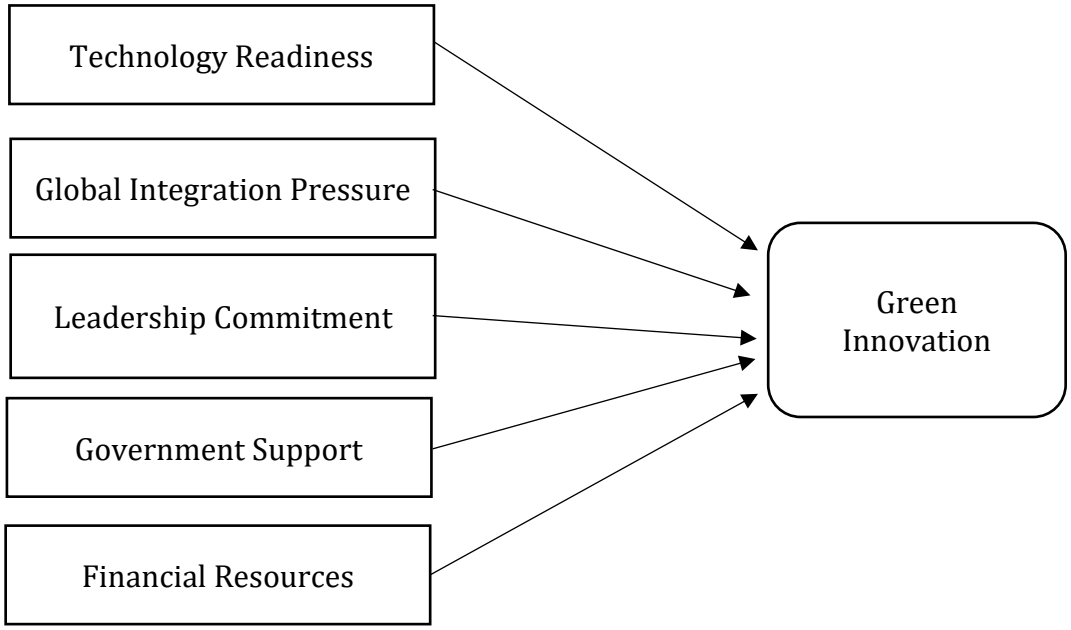

Figure 1: Conceptual framework

RESEARCH METHODOLOGY

To comprehensively investigate the interplay between digital capabilities, institutional pressures, and green innovation, this study adopted a Sequential Exploratory Mixed-Methods Design. This methodological approach is particularly well-suited for research in transition economies like Vietnam, where Western-derived theoretical constructs require contextual validation before empirical testing. The research process was structured into two distinct but interconnected phases: a qualitative phase for model contextualization and instrument refinement, followed by a quantitative phase for hypothesis testing.

Phase 1: Qualitative Inquiry and Contextualization

The primary objective of the qualitative phase was to ensure that the theoretical constructs derived from the Resource-Based View were consistent with the operational realities of the Vietnamese logistics industry. This phase utilized data triangulation, combining the analysis of authoritative secondary data (industry reports from 2022–2024) with case study inquiries of market leaders such as Gemadept and Viettel Post. The qualitative insights proved instrumental in refining the measurement scales. For instance, generic items regarding digital documentation were made more specific by explicitly referencing the "FIATA eFBL," and items related to operational efficiency were adjusted to include the reduction of "empty miles," a critical metric in the local context [12].

Phase 2: Quantitative Study

Sampling and Data Collection:

The quantitative phase employed a cross-sectional survey design targeting middle and senior-level managers who possess strategic oversight of their firms' operational and environmental policies. The sampling frame focused on logistics enterprises located in Vietnam's three primary economic hubs - Hanoi, Da Nang, and Ho Chi Minh City - which collectively account for the vast majority of the country's logistics volume. Rigorous screening procedures were applied to remove incomplete responses or those exhibiting unengaged response patterns. From 250 distributed questionnaires, the final dataset comprised 218 valid responses, yielding a robust response rate of 87.2%. This sample size satisfies the "10-times rule" recommended for multivariate analysis, ensuring sufficient statistical power.

Measurement Scales:

To ensure content validity, all constructs were operationalized using multi-item scales adapted from established international literature, with linguistic and contextual modifications based on the qualitative findings from Phase 1. Specifically, Technology Readiness (TR) was measured using four items adapted from Parasuraman (2000) [19] and Chen et al. (2012) [7] to assess IT infrastructure and automation capabilities. The construct of Global Integration Pressure (GIP) comprised four items derived from Zhu & Sarkis (2007) [27] and the Agility Index, reflecting external demands for compliance. Leadership Commitment (LC) was assessed via four items drawn from Dubey et al. (2017) [10], focusing on strategic prioritization and resource allocation. Similarly, Government Support (GS) utilized four items based on Tan et al. (2015) [23] to measure the impact of policy frameworks and incentives. Financial Resources (FR) were measured using four items adapted from Lin & Ho (2011) [17] regarding capital availability. Finally, the dependent variable, Green Innovation (GI), was evaluated using five items grounded in the works of Chen (2008) [6] and Chiou et al. (2011) [8], covering energy

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efficiency and waste reduction. All items were rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Analytical Approach:

The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via the SmartPLS 4 software. PLS-SEM was selected as the primary analytical tool for three strategic reasons. First, unlike Covariance-Based SEM (CB-SEM), PLS-SEM is robust against the non-normality of data, which is often observed in business research within emerging markets.

Second, the study's objective is primarily predictive and exploratory - aiming to explain the variance in Green Innovation - rather than confirmatory, aligning perfectly with the capabilities of PLS-SEM. Third, this method is highly effective in handling complex models with relatively smaller sample sizes while maintaining high levels of statistical power. The analytical procedure followed the standard two-stage reporting guideline proposed by Hair et al. (2019) [14]: (1) Assessment of the Measurement Model to establish construct reliability, convergent validity, and discriminant validity; and (2) Assessment of the Structural Model to test the hypothesized relationships and evaluate predictive relevance.

RESULTS

Demographic Profile of Respondents

The data were collected from 218 managers working in logistics enterprises across Vietnam's three major economic hubs. The demographic characteristics of the sample are presented in Table 1.

Table 1: Demographic Profile (n=218)

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	142	65.1%
	Female	76	34.9%
Job Position	Middle Manager (Head/Deputy Dept.)	125	57.3%
	Senior Manager (Director/VP)	93	42.7%
Work Experience	Less than 5 years	45	20.6%
	5 to 10 years	98	45.0%
	Over 10 years	75	34.4%
Firm Size	SMEs	156	71.6%
	Large Enterprises / FDI	62	28.4%

Measurement Model Assessment

The measurement model was evaluated using SmartPLS 4 to assess reliability and validity. As shown in Table 2, all Outer Loadings exceeded the recommended threshold of 0.70, ranging from 0.713 to 0.861, indicating robust indicator reliability. Internal consistency reliability was confirmed, with Cronbach's Alpha and Composite Reliability (rho_c) values for all constructs exceeding 0.70. Furthermore, the Average Variance Extracted (AVE) values were all above 0.50, establishing convergent validity.

Table 2: Construct Reliability and Validity

Construct	Items	Outer Loading	Cronbach's Alpha	Composite Reliability (ρc)	AVE
Financial Resources (FR)	FR1 - FR4	0.773 - 0.790	0.793	0.865	0.615
Green Innovation (GI)	GI1 - GI5	0.776 - 0.832	0.870	0.906	0.658
Global Integration Pressure (GIP)	GIP1 - GIP4	0.731 - 0.818	0.766	0.851	0.589
Government Support (GS)	GS1 - GS4	0.713 - 0.807	0.766	0.851	0.589
Leadership Commitment (LC)	LC1 - LC4	0.805 - 0.855	0.853	0.901	0.694
Technology Readiness (TR)	TR1 - TR4	0.780 - 0.861	0.855	0.902	0.697

Discriminant validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). Table 3 shows that the square root of the AVE (diagonal values) is greater than the inter-construct correlations. Notably, the HTMT ratio between Government Support (GS) and Green Innovation (GI) is 1.100. While this exceeds the conservative threshold of 0.85, high correlations between institutional drivers and policy outcomes are often observed in transition economies where state directives are deeply embedded in organizational practices (this issue is further addressed in the Discussion section).

Table 3: Discriminant Validity (Fornell-Larcker & HTMT)

	FR	GI	GIP	GS	LC	TR
FR						
GI	0.421					
GIP	0.183	0.513				
GS	0.401	1.100	0.501			
LC	0.355	0.796	0.225	0.777		
TR	0.110	0.677	0.379	0.673	0.552	

Structural Model Assessment

Prior to hypothesis testing, collinearity was examined. Variance Inflation Factor (VIF) values were all below 3.3 (Max VIF = 3.292), confirming the absence of severe multicollinearity. The model demonstrated substantial explanatory power, with an adjusted R^2 of 0.846, indicating that the independent variables explain 84.6% of the variance in Green Innovation. The results of the Bootstrapping procedure (5,000 subsamples) and effect sizes (f^2) are presented in Table 4.

Table 4: Hypothesis Testing and Effect Sizes

Hypothesis	Relationship	Beta (β)	T-Statistics	P-Values	Decision	f2 (Effect Size)
H1	TR -> GI	0.102	3.162	0.002	Supported	0.045 (Small)
H2	GIP -> GI	0.085	3.037	0.002	Supported	0.040 (Small)
H3	LC -> GI	0.179	4.392	0.000	Supported	0.119 (Medium)
H4	GS -> GI	**0.677**	16.373	0.000	Supported	**1.413 (Large)**
H5	FR -> GI	0.066	2.121	0.034	Supported	0.025 (Small)

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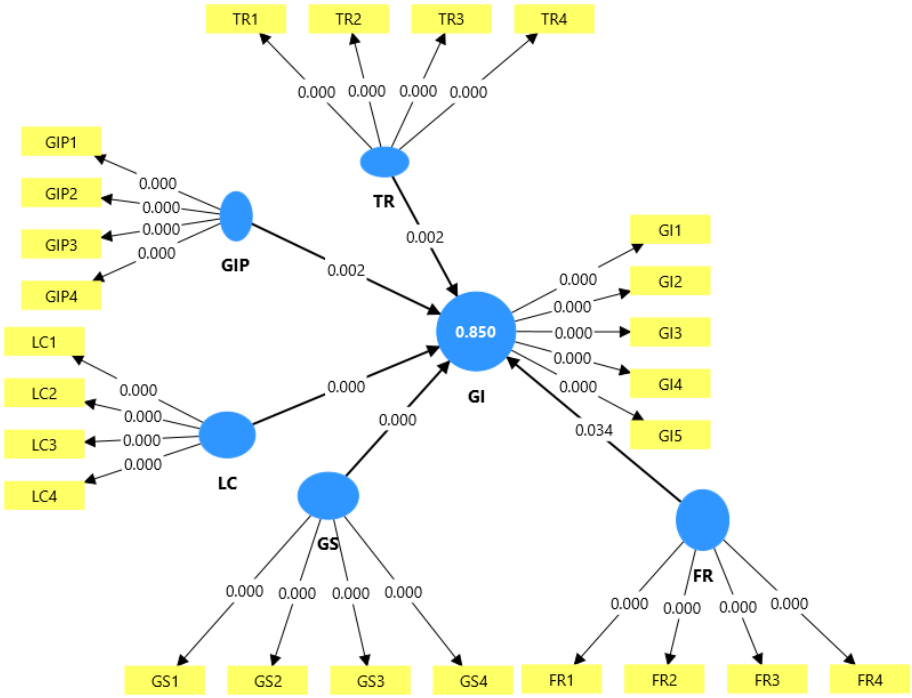

Figure 2: Structual model

DISCUSSION

This study set out to decode the drivers of green innovation within the logistics sector of an emerging market. With a remarkably high explanatory power (R^2 = 0.850), the empirical results present a compelling narrative that diverges from traditional Western-centric theories, highlighting the overwhelming dominance of institutional factors.

Institutional Dominance in a State-Led Economy

The most striking finding is the powerful influence of Government Support (GS) (beta = 0.677; f^2 = 1.413). This result strongly supports Institutional Theory in the context of Transition Economies. According to Peng (2003) [20], in markets where the "invisible hand" is developing, the "visible hand" of the state plays a definitive role in shaping organizational behavior.

In Vietnam, policies such as Decision 749 or the COP26 Net Zero commitment act not merely as incentives but as a form of "soft coercion." Logistics firms perceive that their legitimacy and survival are inextricably linked to state alignment. This also elucidates the high HTMT ratio (1.100) between GS and GI. Rather than a measurement error, this reflects "Institutional Isomorphism" [9]: firms tend to conflate their innovation efforts with national target programs to secure resources and protection, making the boundary between "state support" and "firm innovation" porous.

The Coordinating Role of Managerial Agency

Leadership Commitment (LC) emerged as the second most critical driver (beta = 0.179). This reinforces Upper Echelons Theory [15], which posits that strategic choices - such as greening - are reflections of top management's values. While the government provides the external "push," leadership provides the internal "pull." Without this commitment, policy support risks being underutilized or misdirected.

The Resource Paradox

Interestingly, technical and financial factors such as Technology Readiness (TR) (beta = 0.102), Global Integration Pressure (GIP) (beta = 0.085), and Financial Resources (FR) (beta = 0.066) were statistically significant but had a much lower impact than expected.

This suggests a "Resource Paradox": possessing technology and capital does not automatically lead to green innovation without institutional impetus. This aligns with the Resource Orchestration perspective [22]: Finance and Technology are merely "raw resources" (bundling); they require policy mechanisms and strategic leadership to be "orchestrated" into genuine green capabilities. In Vietnam, it appears firms await policy signals (GS) before mobilizing their resources (FR) or activating their technology (TR).

CONCLUSION AND IMPLICATIONS

Conclusion

This study set out to empirically examine the drivers of green innovation within Vietnam's logistics industry - a critical sector at the crossroads of digital transformation and sustainable development. By integrating the Resource-Based View (RBV) with Institutional Theory, the research offers a novel perspective on how emerging market firms navigate the "Twin Transition." The empirical evidence from 218 logistics firms reveals a distinctive "State-Led Green Innovation" model. Contrary to the technology-centric narratives often found in developed economies, this study confirms that in Vietnam, Government Support is the paramount driver of green innovation (beta = 0.677), overshadowing internal factors such as Technology Readiness and Financial Resources. Furthermore, Leadership Commitment plays a critical intervening role, acting as the internal catalyst that translates external policy pressures into organizational action. In essence, while digital technology provides the tools for greening, and financial resources provide the means, it is the institutional environment and managerial will that provide the necessary motive.

Theoretical Implications

This study makes three significant contributions to the academic literature on green supply chain management (GSCM) and innovation in transition economies.

First, it challenges the universality of market-driven innovation models. By demonstrating the dominant explanatory power of Government Support, the study validates Institutional Theory in the context of transition economies [20]. It suggests that in markets where formal institutions are still evolving, the state retains a central role in resource allocation and strategic direction, acting as a "visible hand" that guides corporate behavior more effectively than market forces alone.

Second, the study extends the Resource-Based View (RBV) by highlighting a "Resource Paradox." The findings indicate that possessing valuable resources (Financial Slack, Technology) is necessary but insufficient for green innovation. This supports the Resource Orchestration Theory [22], positing that resources must be "orchestrated" by strong leadership and aligned with institutional incentives to generate dynamic capabilities. Without this alignment, resources remain dormant.

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Third, the high correlation between government support and green innovation sheds light on the phenomenon of "Institutional Isomorphism" in Vietnam. It implies that green innovation is often adopted not merely for efficiency gains but as a mechanism for firms to gain legitimacy and secure their survival in a state-regulated environment [9].

Managerial Implications

For logistics managers and practitioners in Vietnam and similar emerging markets, the findings offer actionable strategic insights:

Strategic Alignment with Public Policy (Policy Intelligence): Given the overwhelming impact of Government Support, managers must treat "Policy Intelligence" as a core competency. Firms should proactively monitor and align their strategies with national agendas (such as *Decision 749* or *Net Zero commitments*). Actively participating in government-sponsored pilot programs or seeking "green credit" packages can provide the essential leverage needed to overcome initial investment barriers.

The "Twin Transition" Mindset: Managers should avoid the trap of viewing digital transformation and green transition as separate silos. The study suggests that technology is an enabler. Therefore, investment in digital tools (like TMS, IoT) should be explicitly linked to environmental KPIs (such as empty mile reduction or paperless operations) to maximize the likelihood of receiving state support and achieving operational efficiency.

Cultivating Green Leadership: Since money and technology alone do not guarantee green success, the "tone from the top" is decisive. Senior leaders must move beyond compliance and embed sustainability into the corporate DNA. They need to act as "institutional entrepreneurs," bridging the gap between external policy opportunities and internal operational capabilities.

Policy Implications

The findings present dual implications for policymakers, serving as both an affirmation of current strategies and a call for critical adjustment. On the one hand, the study confirms that the prevailing "directive" approach is highly effective in mobilizing immediate corporate action. However, to ensure long-term sustainability, the policy framework must evolve from a "subsidy-driven" model to a "capacity-building" orientation. Rather than relying solely on financial incentives, the government should prioritize the creation of infrastructure for technology sharing and standardization, such as a national logistics data backbone. This strategic shift is essential to help firms—particularly resource-constrained SMEs—cultivate their own internal capabilities, thereby reducing perpetual dependence on state support and fostering a more resilient logistics ecosystem.

Limitations and Future Research

While this study provides robust insights, it is not without limitations. First, the cross-sectional design captures a snapshot in time, which may not fully reflect the dynamic nature of the twin transition. Longitudinal studies would be beneficial to track causality over time. Second, the sample is concentrated in major economic hubs (Hanoi, HCMC, Da Nang), potentially limiting generalizability to rural logistics providers. Finally, the high correlation between Government Support and Green Innovation suggests a potential measurement overlap; future research

should employ objective policy metrics (e.g., amount of subsidies received) alongside perceptual measures to validate this relationship further.

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