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Digital Transformation Driving Customer Participation, Innovation, and Competitive Advantage in Logistics Enterprises

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Abstract

Purpose: This study examines the impact of digital transformation on the competitive advantage of logistics enterprises, with a focus on the mediating roles of customer participation and innovation. Customer participation is highlighted as a key mechanism enabling enterprises to co-create service value, enhance customer experience, and foster innovation. **Research design, data, and methodology:** A quantitative approach was adopted using survey data from 380 managers in logistics enterprises in Ho Chi Minh City, Vietnam. Structural equation modeling (SEM) was employed to test the proposed relationships among digital transformation, customer participation, innovation, and competitive advantage. **Results:** The findings demonstrate that digital transformation has both direct and indirect effects on competitive advantage through customer participation and innovation. Additionally, IT infrastructure, digital leadership capability, organizational agility, competitive pressure, and government support positively influence digital transformation. **Conclusions:** The study underscores the central role of digital transformation in enhancing competitive advantage. It further emphasizes customer participation as a catalyst for innovation and value co-creation. These findings contribute empirical evidence to the literature and provide practical implications for logistics enterprises seeking to implement digital transformation effectively and sustain competitiveness in a dynamic market environment.

Keywords : Logistics, Distribution, Supply Chain Management, Digital Transformation, Customer Participation.

JEL Classification Code: M10, M19, M21, R41

1. Introduction

The robust growth of international trade is inevitably accompanied by substantial challenges, particularly intensifying competition and rapidly evolving customer demands. These challenges are further amplified by the disruptive advancement of digital technologies, which has

fundamentally reshaped supply chain and distribution activities. This convergence of market pressures and technological change creates a new competitive imperative, compelling firms to continuously innovate to sustain their market position and achieve long-term growth. To address this, the extant literature recognizes digital transformation (DT) as a strategic imperative (Vial, 2019).

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DT is not merely the adoption of new technologies but represents a comprehensive restructuring of business operations and organizational models. For logistics enterprises, DT creates opportunities to optimize distribution activities and supply chain management through data integration, process automation, and data-driven decision-making. This process not only enhances operational efficiency and supply chain responsiveness but also fosters a flexible digital interaction model between firms and customers. Through digital platforms, customers can actively participate in the co-creation of value, share information, and provide service feedback, thereby enabling enterprises to customize logistics solutions according to actual needs. This two-way interaction allows enterprises to collect and leverage valuable customer data, gain deeper insights into behaviors, trends, and market expectations, and consequently drive innovation, improve customer experience, and strengthen competitive advantage. Therefore, clarifying the synergistic relationships among digital transformation, customer participation, innovation, and competitive advantage within the logistics context is of particular importance and has emerged as a focal research direction in contemporary academic literature.

However, extant studies in this domain have primarily focused on three distinct research streams. First, a number of studies analyze the factors influencing the digital transformation process (Jović et al., 2022; Zhang et al., 2023a; Verhoef et al., 2021; AlNuaimi et al., 2022). Second, other research investigates the impact of digital transformation on competitive advantage (Leão & Da Silva, 2021; Adisaksana, 2022; Alabdali and Salam, 2022). Third, several studies have focused on the relationship between digital transformation and innovation (Nwankpa & Roumani, 2016; Li et al., 2023; Susanti et al., 2023).

Research gaps: Although these studies provide valuable insights, a comprehensive investigation into the drivers of digital transformation and the intricate interplay among digital transformation, customer participation, innovation, and competitive advantage remains limited. Moreover, these relationships are often mediated by various intermediary factors, underscoring the need for further research to explore these mediators and gain a deeper understanding of their influence. Specifically, the scarcity of studies that simultaneously examine both mediating roles within the logistics sector of emerging markets, such as Vietnam.

In the context of Logistics 4.0, logistics service providers are facing increasingly intense competitive pressures driven by rapid fluctuations in market demand and rising customer expectations for flexibility, speed, and accuracy. Moreover, supply chains and distribution operations have become increasingly multi-layered and complex, requiring superior digital management capabilities, technological competence, and systemic coordination to ensure both efficiency and

agility in operations. With the deep integration of digital technologies, along with trends toward globalization and the personalization of demand, logistics enterprises are compelled to restructure their operational models, innovate management processes, and strengthen digital capabilities to sustain competitive advantage. In response to these challenges, digital transformation has emerged as a crucial strategic imperative, serving as the foundation for restructuring distribution processes, optimizing supply chains, and enhancing organizational responsiveness. Beyond optimizing business operations and reducing operational costs, digital transformation also fosters a real-time interactive ecosystem between firms and customers, improving transparency, strengthening coordination efficiency across the supply chain, and promoting customer co-creation in the design and delivery of logistics services. This transformation has shifted customers from passive consumers to active partners within the value chain, thereby enhancing satisfaction, stimulating service innovation, and creating sustainable competitive advantage for logistics enterprises in the digital era.

Nevertheless, the intricate relationship among digital transformation, customer participation, innovation, and competitive advantage within logistics enterprises remains an area of underexplored inquiry, particularly in developing economies like Vietnam. Investigating this issue is crucial, as it can provide valuable insights for logistics enterprises. Such insights would enable them to strengthen their competitive position and facilitate sustainable development.

Vietnam's logistics industry is recognized as a highly promising market, boasting an estimated annual value of USD 42 billion and exhibiting rapid growth. This sector plays a pivotal role in the national economy (Ministry of Industry and Trade, 2024). Nevertheless, the market remains highly competitive. Although domestic enterprises constitute as much as 89% of the total number of firms, they capture only approximately 30% of the market share (Ministry of Industry and Trade, 2024). This imbalance highlights the inherent competitive limitations faced by local firms. Within this context, Ho Chi Minh City, serving as the nation's economic hub and a strategic trade gateway, has emerged as a crucial logistics center. Consequently, a comprehensive investigation into the challenges associated with digital transformation is of pressing importance. This research is particularly vital for understanding how this process can be integrated with customer participation and innovation activities to bolster the competitive advantage of logistics enterprises.

Building on the issues identified above, this study's primary objective is to investigate the factors influencing digital transformation and its subsequent impact on competitive advantage. A particular focus is placed on elucidating the mediating roles of customer participation

and innovation within logistics enterprises in Ho Chi Minh City. By employing an empirical approach, this research aims to make a dual contribution: first, by advancing the theoretical foundation of this domain, and second, by providing practical evidence to inform managerial strategies. Ultimately, these strategies are intended to bolster the competitive advantage of Vietnamese logistics firms and thereby facilitate the sustainable development of the entire logistics sector.

2. Theoretical Basis

Drawing on the Resource-Based View (RBV) (Barney, 1991), internal resources such as technological infrastructure, customer data, and logistics management systems play a critical role in creating and sustaining competitive advantage. Extending this perspective, the Knowledge-Based View (KBV) (Grant, 1996) underscores knowledge as the most strategic resource, providing the foundation for firms to develop and maintain long-term competitiveness; in particular, customer knowledge significantly enhances innovation capacity and competitive advantage. Likewise, the Dynamic Capabilities framework (Teece et al., 1997) offers a relevant lens for explaining the impact of digital transformation, positing that firms must continuously identify emerging technological opportunities, integrate digital resources into supply chain and distribution processes, and reconfigure business models to remain adaptive to market volatility and evolving customer demands. Moreover, Porter's (1985) theory of competitive advantage suggests that firms can achieve superior performance through strategic positioning, improving supply chain efficiency, optimizing distribution activities, and enhancing service value.

3. Literature Review

3.1. Digital Transformation

Digital transformation (DT) is conceptualized as a strategic organizational change process through which firms leverage digital technologies to restructure business models, optimize operational processes, enhance managerial effectiveness, and create new value for stakeholders (Vial, 2019; Zhao et al., 2023).

In the logistics sector, DT extends beyond the mere adoption of technologies to improve efficiency in core activities like transportation, warehousing, and supply chain management. It also involves elevating the customer experience, developing digitalized services, and implementing innovative business models (Cichosz et al.,

2020). The integration of advanced digital technologies including big data, cloud computing, mobile technologies, and digital twins has become a critical enabler for logistics enterprises, strengthening their forecasting capabilities, increasing organizational agility, fostering innovation capacity, and consolidating their competitive advantage (Jakobsen & Clausen, 2016).

3.2. Customer Participation

Customer participation (CP) is conceptualized as the degree to which customers actively contribute resources, information, and effort throughout the design, production, and delivery of services. This highlights the active role of customers as co-creators of value rather than passive recipients. Earlier conceptualizations, such as that by Dabholkar (2014), define CP as a set of behaviors that directly support the service process. Kelley et al. (1990) emphasize customers' contributions of time, effort, and knowledge in collaboration with service providers. At a broader level, Prahalad and Ramaswamy (2000) view CP as the foundation of value co-creation, which enables customers to participate in the development of innovative and personalized service solutions.

Within the logistics context, CP is reflected in activities such as providing shipment data, offering feedback on service quality, collaborating in supply chain management, and engaging with digital platforms to co-create value. Consequently, CP not only enhances the overall service experience but also plays a strategic role in fostering innovation and strengthening the competitive advantage of logistics enterprises.

3.3. Innovation

Innovation (INNO) is defined as the process by which an organization adopts new ideas, which manifest as the introduction of new products, process improvements, the creation of new services, or changes in management and marketing systems (Maguire et al., 1997). According to Schumpeter (1983), five types of innovation can be distinguished: the introduction of new products, new production techniques, the opening of new markets, the development of new sources of supply, and new industrial structures. Although various conceptualizations of innovation exist, recent studies often consolidate it into four main dimensions: product/service innovation, process innovation, marketing innovation, and organizational innovation (OECD, 2005; Taques et al., 2021).

In the highly competitive logistics sector, innovation is considered a critical survival factor (Cherchata et al., 2022). The very nature of logistics necessitates continuous optimization of speed, efficiency, and accuracy to meet

increasingly complex market requirements. Consequently, the adoption of these forms of innovation becomes particularly significant.

3.4. Competitive Advantage

Competitive advantage (CAD) is commonly defined as a firm's ability to achieve and sustain superior performance relative to its rivals by possessing and leveraging valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). Concurrently, it involves the firm's capacity to reconfigure and adapt its internal and external capabilities in response to dynamic business environments (Teece et al., 1997).

For logistics enterprises, CAD stems not only from cost optimization and operational efficiency but also from the provision of differentiated, integrated, and value-added services (Porter, 1985; Wang, 2017). Within the context of Logistics 4.0, digital transformation plays a pivotal role by enhancing innovation capacity, enabling the development of personalized services, and supporting data-driven decision-making. Furthermore, customer participation emerges as a critical mechanism that facilitates value co-creation, enriches service experiences, and stimulates innovation (Azeem et al., 2021). Consequently, the CAD of logistics enterprises is reinforced not solely by internal resources and capabilities but also by their ability to leverage digital transformation to drive innovation and strategically engage customers as a valuable resource.

4. Methodology

4.1. Hypotheses and Research Model

4.1.1. Hypotheses Development

Information technology infrastructure (ITI) of a firm refers to its capability to deploy shared platforms, manage data effectively, support network communication, and adopt emerging technologies (Lu & Ramamurthy, 2011). The availability and interoperability of IT systems exert a direct influence on the digital transformation process (Jović et al., 2022). Information technology infrastructure plays a crucial role in improving logistics management and facilitating timely access to critical information (Cichosz et al., 2020). IT infrastructure forms the foundation of digital transformation (AlNuaimi et al., 2022) and plays an important role in determining the success of this transformation process (Zhang et al., 2023a). Moreover, IT infrastructure is identified as one of the three core factors that drive successful digital transformation (Vogelsang et al., 2019).

Logistics enterprises focus primarily on real-time data processing and the coordination of vehicles and goods, necessitating a modern IT infrastructure that ensures continuous connectivity, high security, and seamless integration with digital technologies (Le and Dang, 2023). A well-developed IT infrastructure facilitates the effective deployment of digital solutions, automation of operations, optimization of supply chains, and enhancement of customer service (Vogelsang et al., 2019). Based on this foundation, the study proposes the following hypothesis:

H1: Information technology infrastructure positively impacts the digital transformation of logistics enterprises.

Digital transformation leadership (DLED) emphasizes a leader's ability to develop, manage, guide, and apply knowledge of information technology (IT) to enhance the performance of their organization (Le & Dang, 2023). Strategic visionary leadership plays a pivotal role in enabling organizations to effectively adapt to technological disruptions (Vial, 2019). Leadership capabilities have a direct impact on a firm's innovation potential, and this relationship is considered a decisive factor in organizational success (Vogelsang et al., 2019). Expanding on this perspective, Ardi et al emphasize that leadership in the context of digital transformation not only acts as a driving force but also serves as a critical factor in the effective allocation and utilization of resources (Vogelsang et al., 2019).

In the logistics sector, characterized by its complexity and dependence on the coordination of multiple stakeholders, leadership functions such as connection, collaboration, and coordination are essential for optimizing supply chain performance. Based on the aforementioned perspective, this study proposes the following hypothesis:

H2: Digital transformation leadership has a positive impact on digital transformation of logistics enterprises.

Agile organizations are better positioned to effectively adopt and utilize digital technologies (Zhang et al., 2023b; Gong & Ribiere, 2023). Supporting this view, Tijan et al. emphasize the importance of organizational agility in facilitating digital transformation (DT) within the maritime transport sector (Tijan et al., 2021).

The logistics industry requires rapid adaptation to dynamic changes in customer demand, traffic conditions, and partnership dynamics (Cichosz et al., 2020). In this context, organizations with the ability to quickly adjust their structures, processes, human resources, and decision-making models are better positioned to integrate and leverage digital technologies such as WMS, TMS, AI, IoT, and Big Data analytics. Based on this rationale, we propose the following hypothesis:

H3: Organizational agility has a positive impact on digital transformation of logistics enterprises.

Competitive pressure (COMP) compels enterprises to innovate and adopt digital technologies to maintain their market position. Lertwongsatien et al. (2003) define competitive pressure as the primary driving force behind industry-wide change. Fu and Lee (2021) observed that competition accelerates the adoption of digital transformation among SMEs. Similarly, Luo and Yu (2022) and Zhang et al. (2023a) emphasized that market pressure is a critical factor promoting the implementation of digital technologies.

In the context of logistics enterprises, intense competitive pressure drives the acceleration of digital transformation, encompassing the optimization of operational processes, the improvement of service quality, and the personalization of customer experiences. This strategic adaptation allows firms to sustain their competitive advantage and respond rapidly to dynamic market conditions. Based on this rationale, the study proposes the following hypothesis:

H4: Competitive pressure has a positive impact on digital transformation of logistics enterprises.

Government policies (GPOL) play a crucial role in guiding and promoting digital transformation. Chen et al. (2021) emphasize that supportive initiatives, such as digital training, technology grants, and electronic payment incentives, can facilitate the digitalization of businesses. Luo and Yu (2022) and Zhang et al. (2023a) found that such policies help accelerate digitalization across various industries, including logistics. Effectively designed policies enable firms to access the necessary resources to make their digital transformation efforts more effective.

Government support policies are critical drivers of digital transformation in the logistics sector. Incentives like technology investment and workforce training enable firms to implement advanced systems such as WMS and real-time tracking platforms. This adoption optimizes operations, enhances service quality, and reduces costs, ultimately strengthening competitive advantage. Based on this, the study hypothesizes:

H5: Government support policies have a positive impact on digital transformation of logistics enterprises.

Competitive advantage can be achieved through either cost leadership or differentiation from competitors (Porter, 1985). Sustainable CA arises when firms implement effective strategies for the utilization and exploitation of their resources (Barney, 1991). Digital transformation enhances the operational efficiency of logistics enterprises by integrating advanced technologies, such as automation and data analytics, into core business processes (Cichosz et

al., 2020). This is particularly critical in today's rapidly evolving business environment, where streamlined operations are essential for sustaining competitiveness (Adisaksana, 2022).

Within the Logistics 4.0 paradigm, digital transformation is conceptualized as a strategic organizational change process where firms leverage digital technologies to restructure business models, optimize operations, and enhance stakeholder value (Cichosz et al., 2020). Advanced technologies, such as big data, cloud computing, and the Internet of Things (IoT), serve as a catalyst, simultaneously improving forecasting capabilities, increasing organizational agility, and reinforcing competitive advantage. Furthermore, the application of these technologies facilitates real time tracking, transportation route optimization, and accurate demand prediction, thereby reducing operational costs, improving efficiency, and mitigating inherent risks. Based on this, the study hypothesizes:

H6: Digital transformation positively impacts the competitive advantage of logistics enterprises.

Digital transformation enhances both the operational efficiency and innovation capacity of logistics enterprises. The adoption of digital technologies enables these firms to collect and analyze data on transportation, warehousing, customer demand, and delivery routes, thereby supporting proactive decision-making and the optimization of operational activities. The deep integration of big data applications into traditional processes improves demand forecasting, enhances inventory management efficiency, and optimizes the supply chain (Loebbecke & Picot, 2015).

The digitization of the logistics value chain not only fosters innovation in service development and operational processes but also facilitates collaboration with partners within the logistics network, thereby improving service quality and reducing operational costs (Marín et al., 2023). Digital transformation positively impacts innovation by enabling logistics enterprises to develop new operating models, deploy digital platforms that support intelligent delivery, track goods in real time, and personalize customer experiences (Chen et al., 2024).

Big data obtained through these digital platforms plays a pivotal role in enhancing innovation capabilities, improving process efficiency, and creating sustainable competitive advantages (Shahid & Sheikh, 2021). Moreover, Digital transformation helps logistics enterprises reduce communication costs, strengthen connectivity within innovation networks, accelerate the pace of digital integration, expand the scope of knowledge integration, and improve information sharing among partners (Li et al., 2023). Based on this rationale, the study proposes that digital transformation positively influences the innovation

capacity of logistics enterprises, thereby enhancing their competitive advantage and adaptability in a rapidly changing business environment. Based on this finding, the study puts forth the following hypothesis:

H7: Digital transformation has a positive impact on innovation of logistics enterprises.

Digital transformation (DT) plays a vital role in enhancing customer participation by establishing effective communication and interaction platforms between firms and their customers (Zhao et al., 2023). The application of digital technologies facilitates information and knowledge sharing, thereby strengthening customer involvement in business activities (Nambisan et al., 2017). Digital technologies empower customers to intervene at any stage of the production or service delivery process (Rayna & Striukova, 2021). This supports the customization of products and services to individual needs and encourages customers to contribute their knowledge throughout the process (Jin et al., 2020). When firms engage in product personalization, customers are more likely to participate actively in design and production, which, in turn, enhances their level of engagement (Verhoef et al., 2021).

For logistics enterprises, digital transformation is particularly crucial for delivering flexible services and personalizing the customer experience. Digital platforms empower customers to track their orders in real time, select preferred delivery time windows, adjust shipping requirements, and provide direct feedback on service quality. This proactive customer participation not only enhances operational efficiency and reduces errors but also allows logistics firms to design service solutions tailored to individual customer needs. This capability, in turn, strengthens their competitive advantage and improves adaptability in a highly dynamic market environment. Based on the above argument, the study proposes the following hypothesis:

H8: Digital transformation has a positive impact on customer participation in logistics enterprises.

Innovation is considered an essential resource for building a sustainable competitive advantage (Barney, 1991). The entire organization must collaborate to create, share, and integrate new knowledge to foster innovation and adapt to an ever-changing competitive environment (Dess & Picken, 2020). Innovation serves as the foundation for developing distinctive capabilities, which in turn generate competitive advantage (Susanti et al., 2023). In times of uncertainty, innovation is also a prerequisite for ensuring organizational survival (Kafetzopoulos et al., 2019). Therefore, firms with high innovation capability tend to be more flexible in developing new competencies and adapting to change, thereby improving operational performance and

strengthening competitive advantage (Tagues et al., 2021). As a key source of competitive advantage in the knowledge-based economy, innovation enables firms to sustain their competitive position through differentiation (Abd Aziz & Samad, 2016).

For logistics enterprises, innovation is particularly critical for enhancing supply chain efficiency, improving service quality, and rapidly responding to changing customer demands. The implementation of innovative solutions, such as warehouse automation, optimization of transportation routes, the deployment of digital platforms for real-time tracking, and personalized service offerings, allows logistics firms not only to reduce costs and operational risks but also to increase their adaptability to market fluctuations (Wirtz, 2011). Through innovation, logistics enterprises can develop differentiated services, enhance customer experiences, and consolidate sustainable competitive advantages in an increasingly competitive environment (Sut Sakchutchawan et al., 2011). Based on this premise, the study put forward the following hypothesis:

H9: Innovation has a positive impact on the competitive advantage of logistics enterprises.

Knowledge is considered a critical resource that underpins an organization's ability to sustain and develop competitive advantage (Grant, 1996). In the digital era, information and communication technologies facilitate easier access to external knowledge. Notably, digital transformation enables customer involvement in activities such as service design and knowledge sharing (Zhao et al., 2023). Customer knowledge is inherently heterogeneous and serves as a valuable resource to support operations and innovation within organizations (Cai et al., 2022). As end-users of products and services, customers often possess practical insights that are highly valuable (Chatterji et al., 2014).

In the logistics sector, customer participation through digital platforms is crucial for enhancing operational efficiency and fostering innovation. By leveraging customer-provided data on shipping requirements, delivery preferences, and service feedback, enterprises can optimize supply chains, improve service quality, and develop customized logistics solutions. This customer-generated knowledge not only enhances the customer experience but also drives cost reduction and strengthens competitive advantage and adaptability in a dynamic market. Based on these arguments, we propose the following hypothesis:

H10: Customer participation has a positive impact on the competitive advantage of logistics enterprises.

4.1.2. Research Model

The conceptual model developed based on the aforementioned framework and hypotheses, is presented in

Figure 1.

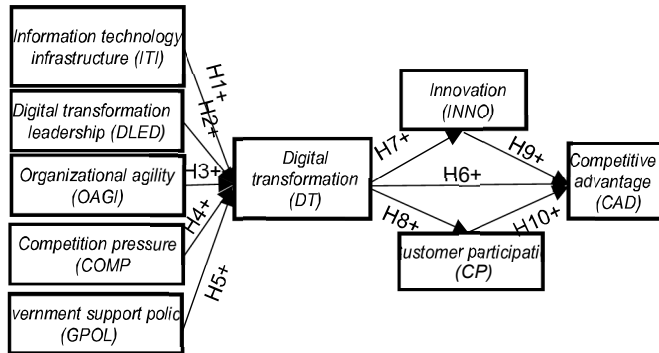


Figure 1: Propose Research Model

4.2. Methodology

4.2.1. Measurements

The measurement scales were adapted from prior research and refined through consultations with 10 experts in logistics, each with over 10 years of experience, to ensure their contextual relevance and reliability. Specifically, the scales for competitive advantage (Azeem et al., 2021), digital transformation (Zhao et al., 2023), customer participation (Ngo & O’Cass, 2013), innovation (Tagues et al., 2021), IT infrastructure (Lu & Ramamurthy, 2011), digital transformation leadership (AlNuaimi et al., 2022), organizational agility (Cegarra-Navarro et al., 2016), competitive pressure (Fu & Lee, 2021), and government support policy (Chen et al., 2021) were modified to fit the research context. Each scale comprised three to four observed variables, which are detailed in Appendix Table S1. The survey questionnaire was developed based on these measurement scales and further validated through expert consultations within the seaport industry. A five-point Likert scale was applied to all measurement items, and additional demographic questions were included to capture the characteristics of respondents.

4.2.2. Data Collection

This study targeted managers of logistics enterprises situated in Ho Chi Minh City, Vietnam. Regarding the sample size, the study adhered to the widely recommended ratio of 5:1 or 10:1, which stipulates that a minimum of five to ten observations are required for each estimated parameter (Hair et al., 2019). A total of 400 questionnaires were distributed, and 20 responses were subsequently excluded due to missing information or a lack of variability in answers across observed variables, indicating a potential response bias. Consequently, 380 valid responses were retained for final analysis. A non-probability sampling method, combining snowball sampling and direct interviews,

was employed to ensure the inclusion of participants with substantial expertise in the logistics sector.

4.2.3. Data Analysis

Structural Equation Modeling (SEM) has emerged as one of the most widely applied research techniques across diverse disciplines, primarily due to its flexibility in modeling complex relationships between independent and dependent variables (Hair et al., 2019; Gefen et al., 2011). In this study, the implementation of SEM followed a two-step approach. First, the reliability and validity of the measurement model were evaluated using several key metrics: factor loadings, Cronbach’s alpha, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT) criterion (Hair et al., 2019; Gefen et al., 2011). Second, the explanatory power and path coefficients of the structural model were analyzed (Hair et al., 2019; Gefen et al., 2011). The SEM analysis confirmed an acceptable model fit based on five key indices: the CMIN/df ratio, the Tucker–Lewis Index (TLI), the Comparative Fit Index (CFI), the Normed Fit Index (NFI), and the Root Mean Square Error of Approximation (RMSEA) (Gefen et al., 2011).

All constructs were measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree." Data analysis was conducted using SPSS (version 26) and AMOS (version 24).

5. Results

5.1. Descriptive Statistics

The survey results reveal a male-dominated demographic, with 79% of respondents being male and only 21% being female, which is characteristic of the logistics industry. The core workforce is concentrated in the 30-to-45-year-old age group, which accounts for 56% of respondents. In contrast, only 8% were over 55, potentially indicating challenges for older workers in adapting to new technologies. The workforce appears stable, with 62.9% of respondents being married.

5.2. Evaluation of the Measurement Model

A reflective measurement model was employed in accordance with established guidelines to evaluate reliability and validity (Hair et al., 2017). Table 1 reports the detailed results, including factor loadings, Cronbach’s alpha, composite reliability (CR), and average variance extracted (AVE). Reliability was examined using both Cronbach’s alpha and composite reliability (CR).

Table 1: Reliability and Validity Measures for Measurement Model Constructs.

Construct	Items	Outer loadings	Cronbach's alpha	CR	AVE
ITI	ITI1	0.808	0.752	0.756	0.508
	ITI2	0.781			
	ITI3	0.854			
DLED	DLED1	0.814	0.841	0.843	0.573
	DLED2	0.832			
	DLED3	0.798			
	DLED4	0.844			
OAGI	OAGI1	0.768	0.814	0.816	0.527
	OAGI2	0.825			
	OAGI3	0.792			
	OAGI4	0.816			
COMP	COMP1	0.790	0.836	0.838	0.565
	COMP2	0.782			
	COMP3	0.856			
	COMP4	0.828			
GPOL	GPOL1	0.774	0.831	0.832	0.554
	GPOL2	0.810			
	GPOL3	0.834			
	GPOL4	0.826			
DT	DT1	0.863	0.847	0.848	0.651
	DT2	0.899			
	DT3	0.863			
INNO	INNO1	0.812	0.821	0.824	0.544
	INNO2	0.846			
	INNO3	0.855			
	INNO4	0.711			
CP	CP1	0.876	0.831	0.833	0.624
	CP2	0.841			
	CP3	0.877			
CAD	CAD1	0.792	0.850	0.851	0.589
	CAD2	0.840			
	CAD3	0.859			
	CAD4	0.831			

The measurement model's reliability and validity were assessed using several key metrics. First, individual item reliability was confirmed, as all outer loadings exceeded the recommended threshold of 0.70 (Hair et al., 2017), indicating a high correlation with their respective constructs. Second, internal consistency was established through Cronbach's alpha values, which were all greater than 0.752, and composite reliability (CR) values ranging from 0.756 to 0.851. These results provide robust evidence for the internal coherence of the constructs (Hair et al., 2017). Third, convergent validity was supported by the Average Variance Extracted (AVE) values, all of which, as shown in Table 1, exceeded the minimum threshold of 0.50 (Hair et al., 2017).

Discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio. As presented in Table 2, all HTMT values were below 0.843, a finding that is well within the recommended threshold proposed by Henseler et al. (2015). This result confirms that each construct is empirically distinct from the others in the model.

These comprehensive reliability and validity assessments confirm the robustness of the measurement model, as all indicators meet the recommended thresholds (Hair et al., 2017; Nunnally & Bernstein, 1994), thereby reinforcing the structural model's capacity to effectively test the proposed hypotheses.

Table 2: HTMT Criterion for Discriminant Validity Assessment

Construct	COMP	DLED	GPOL	OAGI	ITI	DT	INNO	CP	CAD
COMP	0.751								
DLED	0.274	0.757							
GPOL	0.379	0.310	0.744						
OAGI	0.124	0.225	0.301	0.726					
ITI	0.237	0.260	0.264	0.210	0.713				
DT	0.555	0.572	0.555	0.384	0.517	0.807			
INNO	0.321	0.289	0.268	0.176	0.321	0.520	0.738		
CP	0.510	0.601	0.545	0.342	0.469	0.843	0.484	0.790	
CAD	0.479	0.516	0.519	0.310	0.396	0.692	0.542	0.727	0.767

5.3. Evaluation of Structural Model

The results of the Structural Equation Modeling (SEM) analysis demonstrate a satisfactory model fit to the collected market data, as evidenced by the following fit indices: CMIN/df = 1.974 (good fit; Bentler & Bonett, 1980; Nunnally & Bernstein, 1994), TLI = 0.913 (excellent fit; Hu et al., 1995), CFI = 0.920 (excellent fit; Hu et al., 1995), NFI = 0.852 (good fit; Hu et al., 1995), and RMSEA = 0.051 (excellent fit; Hu et al., 1995).

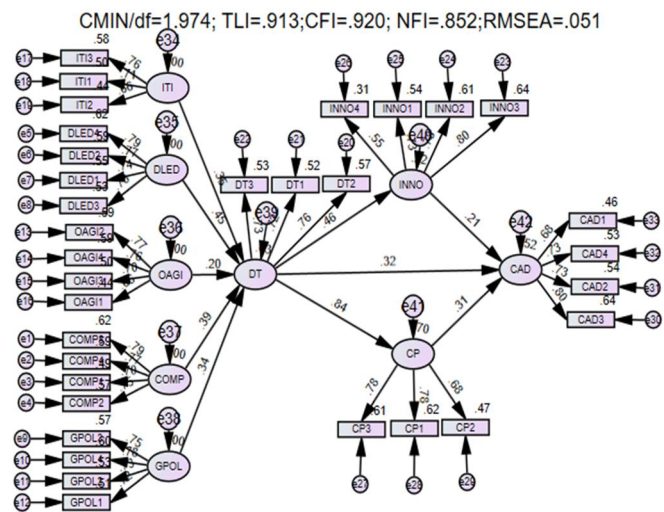


Figure 2: Results of SEM

The results of the structural model evaluation and hypothesis testing, including all significant direct effects, are illustrated in Figure 2. Furthermore, the estimation results presented in Table 3 confirm that all hypothesized

relationships are statistically significant, with p-values less than 0.05.

Table 3: Hypothesis Testing Results from the Structural Model

Hypothesis	Path	Estimate	S.E.	C.R.	P	Decision
H4	DT<--- COMP	0.401	0.053	7.638	***	Accepted
H2	DT<--- DLED	0.391	0.046	8.464	***	Accepted
H1	DT<--- ITI	0.329	0.052	6.387	***	Accepted
H5	DT<--- GPOL	0.337	0.05	6.701	***	Accepted
H3	DT<--- OAGI	0.193	0.046	4.175	***	Accepted
H8	CP<--- DT	0.855	0.069	12.315	***	Accepted
H7	INNI<--- DT	0.502	0.068	7.426	***	Accepted
H6	CAD<--- DT	0.336	0.136	2.469	0.014	Accepted
H10	CAD<--- CP	0.318	0.128	2.477	0.013	Accepted
H9	CAD<--- INNO	0.206	0.056	3.658	***	Accepted

6. Discussion

Digital transformation (DT) positively and significantly impacts the competitive advantage of logistics enterprises ($\beta = 0.336$, $p < 0.05$). This finding is consistent with prior studies conducted by Leão and Da Silva (2021), Verhoef et al. (2021), Adisaksana (2022), and Xue et al. (2022). DT leverages technologies such as Transportation Management Systems (TMS), the Internet of Things (IoT), and real-time tracking solutions to enable logistics enterprises to streamline workflows, minimize operational delays, and optimize resource allocation (Tijan et al., 2021). These results align with previous research indicating that digitalization reduces transaction costs and enhances the reliability of logistics services (Vial, 2019; Alabdali & Salam, 2022). Digital transformation resources, including artificial intelligence (AI), big data, digital applications, and digital infrastructure, provide firms with novel opportunities to develop innovative services, enhance operational performance, and create competitive advantage (Teece, 2010). The integration of such digital technologies plays a critical role in shaping corporate strategies, enabling firms to achieve and sustain competitive advantage (Susanti et al., 2023).

Digital transformation (DT) has a significant positive impact on customer participation in logistics enterprises ($\beta = 0.855$, $p < 0.001$). This finding aligns with the results of prior studies by Zhao et al. (2023) and Xu et al. (2023). Furthermore, customer participation exerts a significant positive influence on the competitive advantage of logistics enterprises ($\beta = 0.318$, $p < 0.05$). This result is consistent with the findings of previous research by Ngo and O’Cass (2013) and Zhao et al. (2023). Through digital platforms, customers are able to specify detailed requirements related to shipping preferences, delivery locations, and preferred

time windows (for example, morning, afternoon, or evening), while simultaneously monitoring their orders in real time. Moreover, these platforms allow customers to provide special instructions such as requesting flexible delivery schedules or advance notifications, thereby making the logistics process more adaptable, personalized, and responsive to individual needs. Embedding customers in the service design and delivery process helps logistics firms develop customized solutions, strengthen relationships, and foster loyalty. This creates a sustainable competitive advantage and differentiates them in a dynamic market.

Digital transformation (DT) has a significant positive impact on the innovation of logistics enterprises ($\beta = 0.502$, $p = 0.000$), aligning with previous research (Chen & Kim, 2023; Li et al., 1981; Susanti et al., 2023). Similarly, innovation positively and significantly influences the competitive advantage of logistics enterprises ($\beta = 0.206$, $p = 0.000$), aligning with previous research (Shahid & Sheikh, 2021; Abd Aziz & Samad, 2016). The integration of digital technologies acts as a strategic lever, fostering a comprehensive innovation ecosystem within logistics that encompasses process innovation (optimizing multimodal transport and smart warehousing), service innovation (personalizing delivery experiences), organizational innovation (data-driven decision-making and enhanced supply chain coordination), and marketing innovation (developing interactive platforms and tailoring customer participation). Within the modern supply chain and distribution context, Digital Transformation (DT) is essential for strengthening transparency, agility, and system resilience. These innovations collectively generate both cost and differentiation advantages, thereby reinforcing the firm’s sustainable competitive position.

The study results confirm that all examined factors exert a statistically significant and positive influence on the Digital Transformation process within logistics enterprises. Specifically, Information Technology Infrastructure ($\beta=0.329$, $p=0.000$) constitutes a critical technical foundation, providing stable systems and essential data storage that enhance operational efficiency and enable data-driven decision-making (Jović et al., 2022). In parallel, DT Leadership ($\beta=0.391$, $p=0.000$) plays a pivotal role in shaping strategic direction, allocating resources, and fostering a digitalization-oriented culture (Vial, 2019). Furthermore, Organizational Agility ($\beta=0.193$, $p=0.000$) strengthens the firm’s adaptive capacity, facilitating operational restructuring and the timely adoption of emerging technologies in response to market volatility (Cichosz et al., 2020).

From an external perspective, Competitive Pressure ($\beta=0.401$, $p=0.000$) emerges as the most influential driver, compelling firms to accelerate technological adoption to respond to environmental dynamics and sustain competitive

advantage (Scott, 1995). Finally, Government Support Policies ($\beta=0.337$, $p=0.000$) contribute to shaping a favorable institutional environment (Luo & Yu, 2022), which is particularly critical for resource-constrained Small and Medium-sized Enterprises (SMEs) in regional logistics hubs like Ho Chi Minh City (Le & Dang, 2023).

This study distinguishes itself from prior research by adopting a comprehensive approach that explores the interrelationships among digital transformation, customer participation, innovation, and competitive advantage, while also accounting for the drivers of DT. The findings underscore the mediating roles of customer participation and innovation, with the estimated path coefficients illustrating the relative influence of each factor, particularly within logistics enterprises in Ho Chi Minh City, Vietnam.

7. Conclusions

This study provides robust empirical evidence that digital transformation exerts a significant positive impact on competitive advantage, customer participation, and innovation. Furthermore, both customer participation and innovation significantly strengthen competitive advantage, confirming their critical roles as strategic mediators in translating digital initiatives into sustainable outcomes. Notably, Information Technology infrastructure, digital leadership, organizational agility, competitive pressure, and government support policies are identified as essential drivers of DT in logistics enterprises.

This study offers significant contributions to both theory and practice. From a theoretical perspective, it clarifies the complex, multi-layered interrelationships among digital transformation, customer participation, innovation, and competitive advantage, thereby extending existing theoretical frameworks on DT, innovation, and strategic competitiveness. Specifically, the findings provide valuable insights into the mechanism through which DT, customer participation, and innovation interact to foster sustainable competitive advantage in logistics enterprises.

From a practical perspective: firstly, the research findings highlight that logistics enterprises need to fully recognize the strategic role of digital transformation in enhancing competitive advantage. Digital transformation has brought about profound changes in the operations of logistics companies, particularly in distribution channels and supply chains. In distribution channels, digital transformation enables the reduction of intermediary layers, increases transparency, and facilitates direct connections with customers, thereby improving service efficiency and reducing operational costs. In supply chains, digital transformation supports the integration and real-time sharing of data among stakeholders, enhancing flexibility,

forecasting capability, and responsiveness to market fluctuations. Consequently, logistics enterprises can strengthen their competitive advantage, improve service quality, and move toward the development of intelligent and sustainable supply chains.

Secondly, this study clarifies the decisive mediating roles of customer participation and innovation in the relationship between digital transformation and competitive advantage among logistics enterprises. Through multidimensional digital interactions and the active involvement of customers in the processes of co-design and co-value creation of services, firms can restructure their distribution channels and supply chains toward a customer-centric orientation. This mechanism enables the integration of data and operational processes across supply chain nodes, thereby enhancing flexibility and market responsiveness. As a result, enterprises not only improve customer experience and strengthen customer participation, but also establish and sustain competitive advantage in the context of digitalized supply chains and a rapidly changing business environment.

Thirdly, logistics enterprises should focus on developing digital data collection, analytics, and sharing systems to enhance decision-making efficiency, optimize distribution activities, and improve supply chain management performance. Leveraging Big Data and predictive analytics enables firms to increase operational efficiency, foster innovation, and proactively manage logistics networks.

Fourthly, small and medium-sized logistics enterprises (SMEs) need to strengthen strategic digital leadership and invest strategically in information technology infrastructure, data management platforms, and supply chain automation systems to improve competitiveness and adaptability.

Fifthly, the government and regulatory bodies play a pivotal role in facilitating digital transformation through tax incentives, digital infrastructure investment, workforce digital upskilling, and the establishment of a coherent legal framework for the digital economy. Such initiatives contribute to enhancing the digital capabilities of the logistics sector, promoting a more integrated, transparent, and sustainable supply chain ecosystem in the digital era.

Although this study makes important contributions, several limitations should be recognized and addressed in future research. First, its geographical scope is restricted to logistics enterprises in Ho Chi Minh City, Vietnam, a region with distinctive economic, social, and logistical characteristics, which may limit the generalizability of the findings. Expanding the study to include logistics firms from other regions or countries would provide a more comprehensive understanding. Second, the use of a non-probability sampling method may introduce bias and reduce the representativeness of the results. Future studies should employ probability sampling methods with larger and more diverse samples to enhance validity and reliability. Third,

while the current model examined five primary antecedents (ITI, DLED, OAGI, COMP, and GPOL) influencing digital transformation, future studies should consider additional organizational factors, such as financial capacity, employee digital competencies, and control variables such as absorptive capacity, to achieve a more holistic understanding.

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Declarations

Ethics Approval and Consent to Participate

This study did not involve human participants or animal subjects.

Conflicts of Interest

The authors declare that they have no competing interests.

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Author Contributions

V.V.N conceived the study, designed the questionnaire, conducted the data collection and analysis, and drafted the original manuscript. T.D.N. provided methodological guidance, supervised the study, and critically revised the manuscript. Q.X.N. contributed to validation and manuscript revision. All authors read and approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

No generative AI or AI-assisted technologies were used in the writing or preparation of this manuscript. Only standard grammar and spell-check tools were utilized.

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Appendixes

Appendix 1: Measurement scale and observed variables

No.	Code	Scales and observed variables
I	ITI	Information technology infrastructure
1	ITI1	The enterprise’s data infrastructure adequately meets the requirements of digital transformation.
2	ITI2	The enterprise’s internet infrastructure sufficiently meets the requirements of digital transformation.
3	ITI3	The enterprise’s technological infrastructure fulfills the requirements of digital transformation.
II	DLED	Digital Transformation Leadership
4	DLED1	The enterprise’s leadership articulates a clear vision for digital transformation and demonstrates a strong commitment to its successful implementation.
5	DLED2	The leadership empowers all members of the organization by effectively communicating the vision and goals of digital transformation.
6	DLED3	The enterprise’s leadership inspires and aligns employees to work cohesively toward the organization’s digital transformation objectives.
7	DLED4	The leadership fosters a proactive culture that encourages all members to contribute ideas and take initiative regarding digital transformation.
III	OAGI	Organizational Agility
8	OAGI1	The organization responds promptly to the evolving needs of both customers and government agencies.
9	OAGI2	The organization effectively adapts its operations and processes in response to changing market demand.
10	OAGI3	The organization demonstrates timely responsiveness to market changes and government regulations through effective decision-making.
11	OAGI4	The organization proactively seeks opportunities for innovation or restructuring to maintain its competitiveness and adaptability.

No.	Code	Scales and observed variables
IV	COMP	Competition pressure
12	COMP1	Competitors have leveraged digital applications to enhance customer relationships.
13	COMP2	The widespread adoption of digital technologies by competitors compels enterprises to follow suit.
14	COMP3	To secure a leading position in the industry, an enterprise is required to undertake digital transformation.
15	COMP4	Industry rivals have strategically implemented digital transformation to gain a competitive advantage.
V	GPOL	Government support policy
16	GPOL1	The legal framework governing digital transformation is well-aligned with the context and the digital transformation initiatives of enterprises.
17	GPOL2	National training programs on digital transformation positively impact enterprises.
18	GPOL3	Government regulatory policies provide supportive incentives that facilitate digital transformation.
19	GPOL4	Government and regulatory agencies provide ongoing support to enterprises in implementing digital transformation solutions and programs.
VI	DT	Digital transformation
20	DT1	The enterprise is leveraging digital technologies to transform its business processes.
21	DT2	The enterprise's operations are gradually shifting toward the adoption of digital technologies.
22	DT3	The enterprise is conducting its business processes using digital technologies.
VII	INNO	Innovation
23	INNO1	The enterprise has introduced or significantly improved its core logistics services, such as transportation, warehousing, freight forwarding, and other value-added services.

No.	Code	Scales and observed variables
24	INNO2	The enterprise has adopted new logistics technologies or processes (such as document digitization, warehouse automation, or transportation/warehouse management systems).
25	INNO3	The enterprise has implemented new marketing methods (service design, pricing packages, pricing policies, or online promotion channels) to attract customers and expand the logistics market.
26	INNO4	The enterprise has undertaken organizational restructuring, management system improvements, or developed new collaborations with supply chain partners to enhance logistics performance.
VIII	CP	Customer Participation
27	CP1	The enterprise interacts with customers to enhance the quality of service delivery.
28	CP2	The enterprise involves customers in the co-design of services to ensure these offerings are tailored to their unique and dynamic requirements.
29	CP3	The enterprise interacts with customers to jointly develop support systems that maximize the value they derive from its services.
VIII	CAD	Competitive advantage
30	CAD1	Over the past three years, the quality of services delivered by the enterprise has consistently outperformed that of its closest competitors.
31	CAD2	Over the past three years, the enterprise has gained market share relative to its closest competitors.
32	CAD3	Over the past three years, the enterprise has achieved a significant improvement in profitability compared to its closest competitors.
33	CAD4	Over the past three years, the enterprise has successfully reduced its operating costs relative to its closest competitors.