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Digital Transformation, Supply Chain Integration, and Supply Chain Resilience: Evidence from Vietnamese Firms

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ABSTRACT: This study examined the impact of Digital Transformation (DT) on Supply Chain Resilience (SCR), while investigating the mediating role of Supply Chain Integration (SCI) and the effect of SCR on Firm Performance (FP) in the Vietnamese context. Data were collected from 400 firms across different industries, firm sizes, ownership types, and geographical regions in Vietnam and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicated that DT had positive effects on SCI ($\beta = 0.451$; $p < 0.001$) and SCR ($\beta = 0.368$; $p < 0.001$); SCI positively affected SCR ($\beta = 0.340$; $p < 0.001$); and SCR positively affected FP ($\beta = 0.457$; $p < 0.001$). Notably, SCI played a complementary partial mediating role in the relationship between DT and SCR, with the indirect effect of DT on SCR through SCI being statistically significant ($\beta = 0.154$; $p < 0.001$). These findings demonstrated that digital transformation not only directly enhanced supply chain resilience but also generated benefits by strengthening information sharing, coordination, and integration among supply chain members. This study provided empirical evidence from Vietnam and highlighted the need for firms to combine investments in digital technologies with stronger supply chain integration to improve their ability to respond to disruptions and enhance firm performance.

KEYWORDS: Digital transformation; supply chain integration; supply chain resilience; firm performance; PLS-SEM; Vietnam.

1. Introduction

In the context of global supply chains increasingly affected by pandemics, geopolitical tensions, market volatility, and logistics disruptions, supply chain resilience (SCR) has become a critical capability that enables firms to maintain operations, adapt to changing conditions, and recover from disruptions [1]. At the same time, digital transformation (DT) has reshaped how firms collect information, manage operations, and make decisions across their supply chains. Recent evidence has indicated that digital transformation positively influences supply chain resilience and firm performance [2–4]. One study also confirmed positive relationships among

digital transformation, supply chain resilience, and firm performance [2]. However, investment in digital technologies does not automatically translate into greater resilience. The value generated by digital transformation also depends on firms' ability to establish connectivity, share information, and coordinate with other supply chain members. Previous studies have shown that supply chain integration (SCI) can enhance resilience through information sharing, joint planning, and coordinated activities [5–7]. Therefore, SCI may serve as an important mediating mechanism through which digital capabilities are translated into the ability to respond to and recover from disruptions. Although previous studies have examined the relationships between digital transformation and supply chain resilience, as well as the contribution of supply chain integration to resilience, further investigation was needed to distinguish the direct effect of digital transformation from its indirect effect through supply chain integration. In particular, understanding the relative contributions of these pathways could help clarify how digital capabilities are translated into supply chain resilience.

Importantly, the ultimate objective of building a resilient supply chain is to maintain and improve firm performance (FP). FP reflects the extent to which a firm achieves desired operational and business outcomes, such as operational efficiency, revenue, profitability, and performance relative to competitors. A resilient supply chain enables firms to minimize losses, maintain operations, meet customer demand, and recover rapidly from disruptions, thereby contributing to improved firm performance. Thus, SCR is not only an outcome of digital capabilities and supply chain integration but may also represent an important mechanism through which these capabilities are translated into superior business outcomes. This issue was particularly relevant to Vietnam, an economy highly integrated into regional and global production networks and supply chains. Digital transformation has been strongly promoted in Vietnam [8], while digital transformation within Vietnamese firms and supply chains has also attracted increasing attention [9, 10]. Nevertheless, further empirical evidence was needed to clarify the mechanisms linking digital transformation, supply chain integration, supply chain resilience, and firm performance. Previous research investigated the relationships among digital technologies, supply chain integration, and firm resilience in the context of COVID-19 [5], while recent evidence from Vietnam examined digital transformation, supply chain competencies, resilience, and performance within specific industrial settings [10, 11]. However, empirical evidence remained limited regarding the mediating role of supply chain integration in the relationship between digital transformation and supply chain resilience across Vietnamese firms from different industries. Furthermore, examining these relationships together with firm performance within an integrated framework could provide additional insights into the organizational mechanisms linking digital transformation to resilience and business outcomes.

Therefore, this study examined the effect of digital transformation on the supply chain resilience of Vietnamese firms, while also testing the mediating role of supply chain integration and the effect of supply chain resilience on firm performance. The findings were expected to provide a clearer understanding of the mechanisms through which digital transformation is translated into supply chain resilience and improved firm performance. In addition, the study provided practical implications for Vietnamese firms regarding how technological investments could be effectively combined with stronger supply chain integration to enhance resilience and organizational performance. Compared with previous studies, this research made three specific contributions. First, it simultaneously examined the direct effect of digital transformation on

supply chain resilience and its indirect effect through supply chain integration, providing a more detailed assessment of the mediating role of SCI. Second, it incorporated firm performance as a downstream outcome of supply chain resilience, thereby connecting digital transformation, supply chain integration, resilience, and business performance within a unified analytical framework. Third, using survey data from 400 Vietnamese firms across different industries, firm sizes, ownership structures, and geographical regions, the study extended existing empirical evidence beyond specific industrial contexts and provided additional insights into supply chain resilience in an emerging economy.

2. Theoretical Framework and Hypothesis Development

2.1. Digital Transformation and Supply Chain Resilience.

Digital transformation (DT) refers to the process through which firms adopt and integrate digital technologies into their operations to transform how information is collected, processes are organized, resources are coordinated, and decisions are made, thereby creating substantial changes in how firms operate and create value [12]. In supply chain management, digital transformation involves not only the adoption of individual technologies but also the ability to leverage data, connect systems, and share information among supply chain members, thereby enhancing coordination, transparency, and supply chain management efficiency [11].

Supply chain resilience (SCR) refers to the ability of firms and their supply chains to prepare for, respond to, recover from, and adapt to disruptive events while maintaining or restoring operations to a desired level [13]. Digital transformation can enhance SCR by improving supply chain visibility and strengthening the ability to collect and process real-time information, thereby enabling firms to identify potential risks at an early stage and make timely response decisions [14, 15]. Faster access to, sharing of, and analysis of data allow firms to flexibly adjust production plans, sourcing, inventory, and distribution in response to changing conditions, thereby strengthening the supply chain's capacity to respond to, recover from, and adapt to disruptions [16, 17]. From the perspective of Dynamic Capabilities Theory, digital transformation strengthens firms' abilities to identify disruptions, respond to environmental changes, and reconfigure resources, thereby enhancing supply chain resilience. These capabilities enable firms to translate digital resources into adaptive responses under uncertain conditions.

Recent empirical evidence has supported this relationship [2]. Li et al. (2026) found a positive relationship between digital transformation and supply chain resilience [2]. Empirical studies in the manufacturing sector have similarly demonstrated the positive effect of digital transformation on SCR. Notably, recent evidence from Vietnamese manufacturing firms has also suggested that supply chain digitalization can enhance supply chain resilience and performance. Furthermore, Aslam et al. (2025) [4] emphasized the roles of adaptability and innovation in explaining how digital transformation contributes to supply chain resilience. Accordingly, this study proposed the following hypothesis:

H1: Digital transformation has a positive effect on firms' supply chain resilience.

2.2. Digital Transformation and Supply Chain Integration.

Supply chain integration (SCI) refers to the extent to which a firm strategically coordinates its internal functions and establishes linkages with external partners to effectively manage supply chain processes. SCI generally encompasses three main dimensions: internal integration, supplier integration, and customer integration, which are manifested through information sharing, coordinated activities, joint planning, and the synchronization of supply chain processes [18].

Digital technologies provide an important foundation for facilitating such integration. The adoption of digital technologies and information systems enhances information-processing capabilities, enabling data to flow rapidly across functional departments while facilitating information exchange with suppliers and customers. Consequently, digital transformation can reduce information fragmentation and asymmetry, break down functional barriers, improve coordination, and strengthen connectivity among supply chain members [5]. Digital technologies such as big data analytics, cloud computing, and the Internet of Things can further facilitate both internal and external integration with suppliers and customers, thereby enhancing transparency and coordination throughout the supply chain [14]. Organizational Information Processing Theory provides an additional explanation for this relationship, suggesting that digital transformation enhances firms' capacity to process and exchange information, thereby reducing uncertainty and facilitating coordination among supply chain partners. Cui et al. (2023) [5] provided empirical evidence supporting the relationship between digital technologies and supply chain integration.

From a dynamic capabilities perspective, technology can generate competitive advantages only when firms are able to transform technological resources into organizational and interorganizational capabilities. Therefore, a higher level of digital transformation is expected to promote greater integration among supply chain members. Accordingly, this study proposed the following hypothesis:

H2: Digital transformation has a positive effect on supply chain integration.

2.3. Supply Chain Integration and Supply Chain Resilience.

Supply chain integration (SCI) can play an important role in enhancing firms' ability to respond to disruptions. When firms maintain a high level of integration with suppliers and customers, information regarding demand, supply, inventory, and potential risks can be exchanged more rapidly. This helps reduce information asymmetry and facilitates coordinated responses among supply chain members when disruptions occur. From the Relational View perspective, SCI enhances resilience by facilitating interorganizational resource sharing, mutual coordination, and collective responses to disruptions. Such collaborative capabilities enable firms to mobilize resources beyond their organizational boundaries and respond more effectively to supply chain uncertainties. Wei et al. (2024) found that supplier integration positively influenced risk management practices and supply chain resilience [7]. In addition, Shen et al. (2023) confirmed significant relationships among supply chain integration, resilience, and supply chain performance [19]. These findings reinforced the theoretical argument that effective coordination among supply chain partners contributes to firms' ability to withstand and recover from disruptions. Therefore, firms with higher levels of supply chain integration were expected

to demonstrate a stronger ability to respond to and recover from disruptions. Accordingly, this study proposed the following hypothesis:

H3: Supply chain integration has a positive effect on supply chain resilience.

2.4. Supply Chain Resilience and Firm Performance.

Firm performance (FP) reflects a firm's ability to achieve desired operational and business outcomes, including operational efficiency, revenue, profitability, and performance relative to competitors. In an environment characterized by considerable uncertainty, supply chain resilience (SCR) can become a critical capability that enables firms to protect and sustain their performance. Firms with resilient supply chains are better able to maintain operations during disruptions, rapidly adjust sourcing and production activities, minimize losses, and restore operations to normal levels. Consequently, SCR can improve operational efficiency, sustain revenue, and reduce the financial losses associated with supply chain disruptions. Dynamic Capabilities Theory suggests that resilient firms can adapt operational processes and reconfigure resources in response to environmental uncertainty, thereby maintaining operational continuity and supporting business performance. This perspective explains how resilience can generate economic value by reducing disruption-related losses and sustaining competitive capabilities.

Previous studies have provided empirical evidence supporting this relationship. Iftikhar et al. (2021) suggested that supply chain resilience was associated with firm performance [20]. Shen et al. (2023) also confirmed that SCR positively affected supply chain performance [19]. More recently, the meta-analysis conducted by Li et al. (2026) demonstrated a positive relationship between SCR and firm performance, with stronger associations observed for operational and market performance than for financial performance [2]. In the Vietnamese context, Matsui et al. (2025) also incorporated digital transformation, supply chain capabilities, resilience, and performance within an integrated analytical framework [21]. Based on these arguments and empirical findings, this study proposed the following hypothesis:

H4: Supply chain resilience has a positive effect on firm performance.

2.5. The Mediating Role of Supply Chain Integration.

Although digital transformation can directly enhance supply chain resilience (SCR), investments in digital technologies may not necessarily lead to greater resilience unless firms are able to translate digital resources into effective coordination capabilities. From a dynamic capabilities perspective, digital technologies provide firms with technological resources and information, while supply chain integration (SCI) enables them to leverage these resources to coordinate with supply chain partners and reconfigure their operations in response to environmental changes. Through this mechanism, digital transformation first enhances connectivity and information-sharing capabilities, thereby promoting SCI. A higher level of integration, in turn, enables firms to better identify, respond to, and recover from supply chain disruptions. In other words, the relationship between DT and SCR may be partially explained through the DT → SCI → SCR pathway. Existing evidence on the relationships among digital technologies, supply chain integration, and resilience has provided theoretical and empirical support for this mediating mechanism [5]. Integrating Dynamic Capabilities Theory and

Organizational Information Processing Theory, SCI can be understood as an organizational mechanism through which digital resources and information-processing capabilities are translated into coordinated supply chain activities and resilience capabilities. Cui et al. (2023) [5] provided empirical support for the role of SCI in linking digital technologies to firm resilience, while Aslam et al. (2025) [4] identified adaptability and innovation as additional mechanisms connecting digital transformation and supply chain resilience. These findings provided a theoretical basis for examining SCI as a mediating pathway alongside the direct relationship between DT and SCR. Therefore, this study proposed the following hypothesis:

H5: Supply chain integration mediates the relationship between digital transformation and supply chain resilience.

3. Research Methodology

3.1. Research Model.

Based on the literature review and the hypotheses developed above, this study proposed a research model to examine the relationships among digital transformation (DT), supply chain integration (SCI), supply chain resilience (SCR), and firm performance (FP). In the proposed model, DT served as the independent variable, SCI acted as a mediator in the relationship between DT and SCR, and FP represented the ultimate outcome variable. The model also incorporated the direct effect of DT on SCR, allowing the study to assess whether SCI partially mediated the relationship between digital transformation and supply chain resilience. The relationships tested in the model included DT → SCR (H1), DT → SCI (H2), SCI → SCR (H3), SCR → FP (H4), and DT → SCI → SCR (H5). Figure 1 illustrates the proposed research model and the hypothesized relationships among the four constructs.

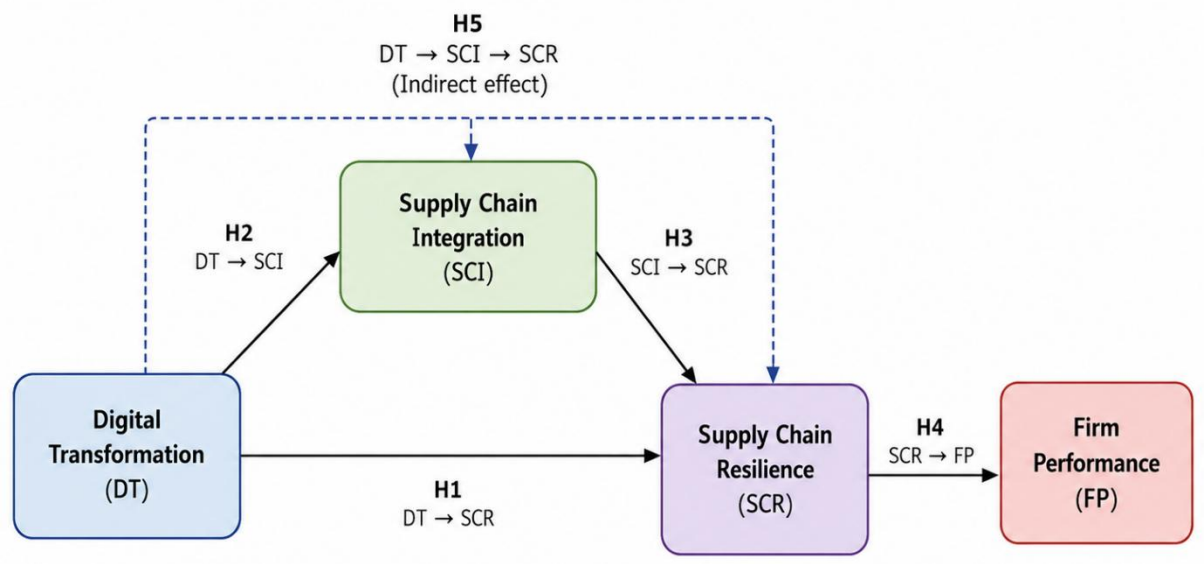


Figure 1. Research Model.

3.2. Measurement Scales and Questionnaire Design.

The measurement scales were adapted from previous studies and modified to suit the context of Vietnamese firms. The questionnaire employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The four constructs were measured using a total of 19

observed variables. Table 1 presents the measurement constructs, corresponding item codes, and statements used in the questionnaire.

Table 1. Constructs and Measurement Items in the Research Model.

Construct	Code	Measurement item
Digital Transformation (DT)	DT1	The firm extensively applies digital technologies in its core business activities.
	DT2	Digital systems are integrated across different functional departments within the firm.
	DT3	The firm regularly uses data and data analytics to support decision-making.
	DT4	The firm uses digital platforms to share information with suppliers and customers.
	DT5	Top management actively promotes and supports digital transformation.
Supply Chain Integration (SCI)	SCI1	Internal functional departments closely coordinate their supply chain activities.
	SCI2	The firm regularly shares information with its suppliers.
	SCI3	The firm closely coordinates its activities with suppliers.
	SCI4	The firm regularly exchanges information with customers.
	SCI5	The firm engages in joint planning with its supply chain partners.
Supply Chain Resilience (SCR)	SCR1	The firm is capable of anticipating and preparing for supply chain disruptions.
	SCR2	The firm is capable of mitigating the impacts of supply chain disruptions.
	SCR3	The firm is capable of responding rapidly when supply chain disruptions occur.
	SCR4	The firm is capable of rapidly restoring operations after supply chain disruptions.
	SCR5	The firm is capable of adapting to changes following supply chain disruptions.
Firm Performance (FP)	FP1	The firm's operational efficiency has improved.
	FP2	The firm's revenue and sales performance has improved.
	FP3	The firm's profitability has improved.
	FP4	The firm's overall performance is better than that of its competitors.

In addition to the main constructs presented in Table 1, the questionnaire collected information on several characteristics of the firms and respondents, including industry, firm size, years of operation, ownership type, geographical region, export activities, and respondents' job positions. These variables were used to describe the sample characteristics and were also considered potential control variables for supplementary analyses.

3.3. Data Collection and Research Sample.

The target population consisted of firms operating in Vietnam across various industries, including manufacturing, logistics, retail, food and beverage, electronics, textiles and garments, and import–export. The questionnaire respondents were individuals with knowledge of their firms' supply chain activities and digital transformation processes, including supply chain managers, logistics managers, operations managers, purchasing managers, and senior managers. Respondents were selected based on their professional responsibilities and familiarity with their firms' digital transformation and supply chain management activities. The questionnaire was developed based on previously validated measurement scales, with the wording subsequently adapted to the Vietnamese research context. Prior to the main survey, the questionnaire was pilot-tested to assess the clarity and comprehensibility of the measurement items. The pilot test focused on identifying unclear or ambiguous questions and assessing the suitability of the measurement items for the Vietnamese business context.

The main survey was conducted using both face-to-face and online questionnaire distribution methods to facilitate participation across different industries and geographical regions. A total of 426 completed questionnaires were collected. Following data collection and screening, incomplete questionnaires and responses showing signs of inconsistency were excluded from the analysis. Consequently, 26 questionnaires were excluded, resulting in 400

valid responses and a usable response rate of 93.9% among the collected questionnaires. The final sample consisted of 400 valid observations. This sample size was considered adequate for PLS-SEM analysis and provided sufficient observations to assess the measurement model and test the structural relationships proposed in the research model.

3.4. Data Analysis.

The data were analyzed using descriptive statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was considered appropriate for this study because it enabled the simultaneous assessment of the measurement model and structural relationships among multiple latent constructs and was particularly suitable for research models with explanatory and predictive objectives.

The analysis was conducted in two stages. First, the measurement model was assessed using outer loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). The measurement scales were considered to demonstrate satisfactory reliability and convergent validity when outer loadings were generally approximately 0.708 or higher, Cronbach's alpha and CR values were at least 0.70, and AVE values exceeded 0.50. Discriminant validity among the constructs was assessed using the Heterotrait–Monotrait ratio (HTMT). HTMT values below 0.85 were considered indicative of satisfactory discriminant validity. The Fornell–Larcker criterion was also applied as a complementary assessment, with the square root of the AVE for each construct expected to exceed its correlations with other constructs.

Second, after satisfactory reliability and validity of the measurement model had been established, the structural model was evaluated using collinearity statistics (VIF), path coefficients (β), coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). The statistical significance of the path coefficients was assessed using bootstrapping with 5,000 resamples, based on t-values, p-values, and bootstrap confidence intervals. For the mediation hypothesis (H5), the indirect effect of DT on SCR through SCI was examined using the specific indirect effect obtained from the bootstrapping results. The mediating effect was considered statistically significant when the indirect pathway DT → SCI → SCR was significant and its bootstrap confidence interval did not include zero. Both the direct and indirect effects were subsequently examined to determine the nature of SCI's mediating role in the relationship between digital transformation and supply chain resilience.

4. Results

4.1. Sample Characteristics.

The study sample consisted of 400 firms, with a relatively balanced distribution across industries. Table 2 presents the characteristics of the sampled firms and respondents, including industry, firm size, ownership structure, geographical region, export activities, and respondent positions. Textile and garment firms accounted for the largest proportion (16.2%), followed by electronics (15.5%) and logistics (15.2%). In terms of firm size, medium-sized firms represented 38.2% of the sample, followed by small firms (33.5%) and large firms (28.2%). The ownership structure was also relatively balanced, comprising state-owned enterprises (27.5%), joint ventures (27.3%), domestic private firms (22.8%), and foreign direct investment

(FDI) firms (22.5%). Geographically, the sampled firms were relatively evenly distributed across Northern Vietnam (32.0%), Central Vietnam (34.0%), and Southern Vietnam (34.0%), while 62.0% of the firms were engaged in export activities. The respondents primarily held managerial positions directly related to supply chain management, procurement, logistics, and operations. Overall, the sample exhibited considerable diversity in terms of industry, firm size, ownership structure, and geographical location, providing an appropriate basis for examining the relationships proposed in the research model.

Table 2. Sample Characteristics.

Characteristic	Category	Frequency (n)	Percentage (%)
Industry	Manufacturing	56	14.0
	Logistics	61	15.2
	Retail	51	12.8
	Food & Beverage	55	13.8
	Electronics	62	15.5
	Textile & Garment	65	16.2
	Import–Export	50	12.5
Firm size	Small (<50 employees)	134	33.5
	Medium (50–199 employees)	153	38.2
	Large (≥200 employees)	113	28.2
Ownership	Private domestic	91	22.8
	FDI	90	22.5
	State-owned	110	27.5
	Joint venture	109	27.3
Region	Northern Vietnam	128	32.0
	Central Vietnam	136	34.0
	Southern Vietnam	136	34.0
Export activity	Yes	248	62.0
	No	152	38.0
Respondent position	Supply Chain Manager	84	21.0
	Logistics Manager	73	18.2
	Operations Manager	80	20.0
	Procurement Manager	99	24.8
	Senior Executive	64	16.0

4.2. Measurement Model Assessment.

The measurement model assessment indicated that all constructs met the recommended criteria for reliability and convergent validity. As presented in Table 3, the outer loadings of the measurement items ranged from 0.802 to 0.861, all exceeding the recommended threshold of 0.70 [22]. The variance inflation factor (VIF) values ranged from 1.878 to 2.410, remaining below the threshold of 5 and indicating no significant multicollinearity concerns. Cronbach's alpha (CA) values ranged from 0.859 to 0.892, while composite reliability (CR) values ranged from 0.904 to 0.921, all exceeding the recommended threshold of 0.70 and thus confirming satisfactory internal consistency reliability. In addition, the average variance extracted (AVE) values ranged from 0.678 to 0.702, exceeding the recommended threshold of 0.50 and demonstrating adequate convergent validity [22, 23]. Overall, the DT, FP, SCI, and SCR constructs satisfied the recommended criteria for reliability and convergent validity, providing a sound basis for the subsequent assessment of discriminant validity and the structural model.

Table 3. Reliability and Convergent Validity Assessment.

Construct	Item	Outer Loading	VIF	CA	CR	AVE
DT	DT1	0.802	1.942	0.892	0.921	0.699
	DT2	0.859	2.405			
	DT3	0.829	2.200			
	DT4	0.845	2.274			
	DT5	0.845	2.242			
FP	FP1	0.827	1.884	0.859	0.904	0.702
	FP2	0.844	1.944			
	FP3	0.836	2.085			
	FP4	0.844	2.025			
SCI	SCI1	0.830	2.161	0.892	0.921	0.699
	SCI2	0.832	2.169			
	SCI3	0.861	2.410			
	SCI4	0.828	2.076			
	SCI5	0.828	2.166			
SCR	SCR1	0.802	1.878	0.881	0.913	0.678
	SCR2	0.827	2.067			
	SCR3	0.842	2.263			
	SCR4	0.819	2.047			
	SCR5	0.825	2.068			

The assessment of discriminant validity using the Fornell–Larcker criterion showed that the square roots of the AVE for DT (0.836), FP (0.838), SCI (0.836), and SCR (0.823), presented along the diagonal in Table 4, were all greater than the corresponding correlations between each construct and the other constructs. According to Fornell and Larcker (1981), this indicated that each construct shared more variance with its own indicators than with other constructs. Therefore, the measurement scales satisfied the requirements for discriminant validity, demonstrating that DT, FP, SCI, and SCR were empirically distinct constructs [22].

Table 4. Discriminant Validity Assessment Using the Fornell–Larcker Criterion.

Construct	DT	FP	SCI	SCR
DT	0.836			
FP	0.430	0.838		
SCI	0.451	0.349	0.836	
SCR	0.521	0.457	0.506	0.823

The assessment of discriminant validity using the Heterotrait–Monotrait ratio (HTMT) showed that the HTMT values among the constructs ranged from 0.397 to 0.586, all below the recommended threshold of 0.85 [22, 24]. Specifically, Table 5 shows that the HTMT values were 0.490 for DT–FP, 0.504 for DT–SCI, 0.586 for DT–SCR, 0.397 for FP–SCI, 0.523 for FP–SCR, and 0.569 for SCI–SCR. The highest HTMT value was observed between DT and SCR (0.586), but it remained substantially below the recommended threshold. These results confirmed that DT, FP, SCI, and SCR were empirically distinct constructs. Taken together with the Fornell–Larcker criterion, the HTMT results demonstrated satisfactory discriminant validity of the measurement model, supporting its suitability for subsequent structural model assessment.

Table 5. Discriminant Validity Assessment Using HTMT.

Construct	DT	FP	SCI	SCR
DT	–			
FP	0.490	–		
SCI	0.504	0.397	–	
SCR	0.586	0.523	0.569	–

4.3. Model Fit Assessment.

The model fit assessment showed that the standardized root mean square residual (SRMR) value for the estimated model was 0.068, which was below the recommended threshold of 0.08, indicating a good fit between the model and the observed data [22, 25]. As presented in Table 6, the normed fit index (NFI) value was 0.915, exceeding the threshold of 0.90 and indicating an acceptable level of model fit. The d_ULS (0.873) and d_G (0.161) values provided additional information regarding the discrepancy between the empirical correlation matrix and the model-implied correlation matrix; however, these indices required evaluation against bootstrap-based percentile values rather than fixed cutoff criteria [26]. Overall, particularly based on the SRMR and NFI values, the model demonstrated an acceptable level of fit and was considered suitable for the subsequent assessment of the structural relationships.

Table 6. Model Fit Assessment.

Index	Saturated Model	Estimated Model
SRMR	0.045	0.068
d_ULS	0.382	0.873
d_G	0.147	0.161
Chi-square	342.670	367.899
NFI	0.921	0.915

4.4. Structural Model and Hypothesis Testing.

The structural model results showed that all hypothesized relationships were statistically significant at $p < 0.001$. Table 7 presents the path coefficients, t-values, effect sizes, significance levels, and hypothesis-testing decisions. Digital transformation (DT) had a positive effect on supply chain resilience (SCR) ($\beta = 0.368$; $t = 8.542$), supporting H1, and supply chain integration (SCI) ($\beta = 0.451$; $t = 10.847$), supporting H2. Furthermore, SCI positively affected SCR ($\beta = 0.340$; $t = 7.718$), supporting H3, while SCR positively affected firm performance (FP) ($\beta = 0.457$; $t = 11.074$), supporting H4. The effect sizes (f^2) ranged from 0.145 to 0.264, indicating small to medium effects according to commonly applied PLS-SEM criteria [22]. Overall, all four direct-effect hypotheses were supported, demonstrating statistically significant relationships among DT, SCI, SCR, and FP.

Table 7. Results of Hypothesis Testing.

Hypothesis	Relationship	β	*t*	f^2	*p*-value	Effect Size (f^2)	Decision
H1	DT → SCR	0.368	8.542	0.169	< 0.001	Medium	Supported
H2	DT → SCI	0.451	10.847	0.256	< 0.001	Medium	Supported
H3	SCI → SCR	0.340	7.718	0.145	< 0.001	Small	Supported
H4	SCR → FP	0.457	11.074	0.264	< 0.001	Medium	Supported

Figure 2 illustrates the structural model results, showing the estimated relationships among the four constructs. The strongest standardized path coefficient was observed between SCR and FP ($\beta = 0.457$), followed by DT and SCI ($\beta = 0.451$), DT and SCR ($\beta = 0.368$), and

SCI and SCR (β = 0.340). These findings indicated that digital transformation was associated with greater supply chain resilience both directly and through its relationship with supply chain integration. Moreover, supply chain resilience was positively associated with firm performance, highlighting its importance within the proposed structural model.

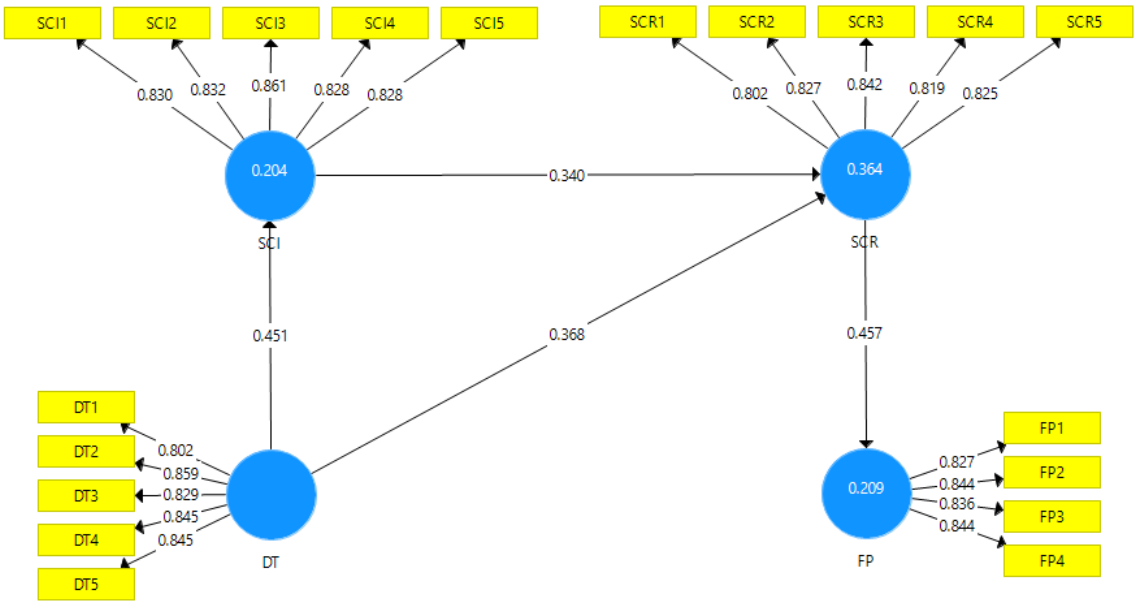


Figure 2. Results of the Structural Model.

4.5. Mediating Role of Supply Chain Integration.

As presented in Table 8, the indirect effect analysis showed that digital transformation (DT) had a positive and statistically significant indirect effect on supply chain resilience (SCR) through supply chain integration (SCI) (β = 0.154; STDEV = 0.023; t = 6.596; p < 0.001). The bias-corrected 95% bootstrap confidence interval for the indirect effect ranged from 0.111 to 0.200, excluding zero and providing further evidence of its statistical significance. This result confirms the mediating role of SCI in the relationship between DT and SCR, thereby supporting H5. Furthermore, because the direct effect of DT on SCR remained statistically significant (β = 0.368; p < 0.001) and had the same direction as the indirect effect, SCI exhibited complementary partial mediation. This finding indicates that digital transformation enhances supply chain resilience both directly and indirectly by strengthening supply chain integration [22].

Table 8. Indirect Effect and Mediation Analysis of SCI.

Indirect Effect	β	STDEV	*t*	*p*-value	95% CI	Conclusion
DT → SCI → SCR	0.154	0.023	6.596	< 0.001	[0.111, 0.200]	Significant

5. Discussion

The findings provided empirical evidence of the important role of digital transformation in strengthening supply chain resilience among Vietnamese firms and clarified the organizational mechanisms underlying this relationship. All hypothesized relationships were statistically significant. Digital transformation (DT) positively affected supply chain integration (SCI) (β =

0.451; $p < 0.001$) and supply chain resilience (SCR) ($\beta = 0.368$; $p < 0.001$). SCI positively affected SCR ($\beta = 0.340$; $p < 0.001$), while SCR positively affected firm performance (FP) ($\beta = 0.457$; $p < 0.001$). Furthermore, SCI demonstrated complementary partial mediation in the relationship between DT and SCR, with a significant indirect effect ($\beta = 0.154$; $p < 0.001$). These results indicated that digital transformation contributed to resilience through both direct technological capabilities and improved coordination among supply chain partners.

The positive relationship between DT and SCR suggested that firms with higher levels of digital transformation were better positioned to anticipate, respond to, recover from, and adapt to supply chain disruptions. This finding was consistent with previous studies demonstrating that digital technologies improved supply chain visibility, information accessibility, and decision-making capabilities [2–4, 14–17]. Digital technologies enabled firms to monitor demand fluctuations, inventory availability, supplier performance, and logistics conditions, facilitating timely operational adjustments. This finding was particularly relevant to Vietnam, where firms increasingly participated in international production networks and faced complex supply chain uncertainties. The Vietnamese Ministry of Industry and Trade identified persistent challenges involving logistics costs, insufficient coordination between transportation and warehousing, and uneven digital technology adoption [27]. Accordingly, the results suggested that digital transformation could serve as a strategic capability for improving supply chain responsiveness and reducing operational vulnerability.

The positive effect of DT on SCI ($\beta = 0.451$) further demonstrated the importance of digital technologies in facilitating information exchange and coordination across organizational boundaries. This result was consistent with Cui et al. (2023) [5] and previous research on digital supply chain management [11, 15], which emphasized the role of integrated information systems, digital platforms, and data-sharing capabilities in reducing information fragmentation. However, technological adoption alone did not necessarily ensure effective integration. A World Bank study of Vietnamese small and medium-sized enterprises reported that approximately 80% of participating firms initially adopted enterprise resource planning systems following training, but adoption subsequently declined to approximately 40% and eventually 35% after 18 months [28]. This evidence highlighted the importance of sustaining technological adoption and embedding digital systems into routine organizational practices. The findings therefore suggested that firms needed to complement digital investments with standardized information-sharing procedures, coordinated planning, and stronger supplier–customer relationships.

SCI also had a significant positive effect on SCR ($\beta = 0.340$), reinforcing the importance of interorganizational collaboration in strengthening supply chain resilience. This finding supported previous research demonstrating that supplier integration, information sharing, and coordinated activities improved firms' ability to manage disruptions [6, 7, 19]. Through effective integration, firms could exchange information concerning production schedules, inventory levels, material availability, and transportation constraints, enabling coordinated responses to unexpected disruptions. This relationship was particularly important for Vietnamese firms operating within interconnected domestic and international supply networks. In the present sample, 62% of firms participated in export activities, while respondents represented manufacturing, electronics, textiles, logistics, and other industries. These characteristics highlighted the relevance of supply chain integration in environments where

organizational performance depended on the reliability and responsiveness of multiple business partners.

The positive relationship between SCR and FP ($\beta = 0.457$; $f^2 = 0.264$) indicated that supply chain resilience was associated with improved business outcomes. This finding was consistent with previous studies linking resilience to operational continuity, efficiency, and organizational performance [2, 19, 20]. Firms with stronger resilience capabilities were better positioned to maintain production, reduce downtime, minimize disruption-related losses, and meet customer requirements. In Vietnam, these capabilities were especially relevant because logistics and international trade represented important components of economic activity. The Vietnamese Ministry of Industry and Trade reported annual logistics sector growth of approximately 14–16%, with an estimated market size of USD 40–42 billion [29]. Therefore, the findings suggested that strengthening supply chain resilience could contribute not only to risk management but also to operational competitiveness and long-term business performance.

An important contribution of this study was the identification of SCI as a complementary partial mediator between DT and SCR. The significant indirect effect ($\beta = 0.154$; $p < 0.001$), together with the significant direct effect ($\beta = 0.368$; $p < 0.001$), indicated that digital transformation was associated with resilience through two complementary pathways. First, digital technologies directly supported resilience by improving information visibility, forecasting, monitoring, and operational decision-making. Second, digital transformation strengthened supply chain integration, which subsequently facilitated coordinated responses to disruptions. These findings extended previous research [4, 5, 7] by demonstrating the importance of interorganizational integration as a mechanism connecting digital capabilities with supply chain resilience. However, the persistence of the direct effect indicated that integration was not the only pathway through which digital transformation contributed to resilience.

From a theoretical perspective, the findings supported Dynamic Capabilities Theory by demonstrating how digital capabilities were associated with firms' abilities to respond to changing environmental conditions. The mediating role of SCI also supported Organizational Information Processing Theory, which emphasized the importance of information exchange and coordination in managing uncertainty. By incorporating firm performance as an outcome of supply chain resilience, the study further connected technological capabilities, interorganizational integration, and organizational performance within a unified framework. The evidence from 400 Vietnamese firms across different industries contributed to the understanding of these relationships in an emerging-economy context.

The findings also provided practical implications for firms and policymakers. Vietnamese firms were encouraged to integrate digital investments with organizational processes that promoted information sharing, supplier collaboration, and coordinated decision-making. Technologies such as enterprise resource planning, cloud computing, the Internet of Things, and data analytics could provide limited resilience benefits when information remained isolated within departments or was not shared with supply chain partners. Previous assessments of Vietnam's logistics sector similarly highlighted weaknesses in digital connectivity and coordination [8, 27]. Furthermore, Vietnam's logistics development strategy for 2025–2035 established a target for 80% of logistics service enterprises to adopt digital transformation solutions by 2035 [30]. These policy directions reinforced the importance of improving system interoperability, data standardization, and collaboration across supply chain networks.

Overall, the findings demonstrated that digital transformation, supply chain integration, and supply chain resilience were interconnected capabilities associated with improved firm performance. Digital technologies provided information-processing and connectivity capabilities, while supply chain integration facilitated coordinated responses to disruptions. Together, these capabilities contributed to stronger resilience and better organizational outcomes. The results emphasized that successful digital transformation required more than technological investment; it also depended on firms' ability to integrate digital resources into effective supply chain coordination and management practices.

6. Conclusions

This study examined the relationships among digital transformation (DT), supply chain integration (SCI), supply chain resilience (SCR), and firm performance (FP) in Vietnamese firms. The findings indicated that DT positively affected both SCI and SCR, while SCI further strengthened SCR, and SCR positively influenced FP. Importantly, SCI exhibited complementary partial mediation in the relationship between DT and SCR, demonstrating that digital transformation contributed to supply chain resilience through both direct and indirect pathways. These findings highlighted the importance of combining digital technology investments with effective information sharing, coordination, and collaboration among supply chain partners. From a practical perspective, Vietnamese firms were encouraged to strengthen digital connectivity and supply chain integration to improve their responsiveness to disruptions and organizational performance. Nevertheless, the study had several limitations. Its cross-sectional design restricted causal interpretation, while differences across industries could have influenced the relationships examined. The reliance on self-reported questionnaire data also introduced potential common method bias, and the focus on Vietnamese firms limited the generalizability of the findings. Future research could employ longitudinal designs, investigate industry-specific differences, incorporate objective performance indicators, and examine additional mediating or moderating variables to provide a more comprehensive understanding of digital transformation and supply chain resilience.

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Author Contribution

Trinh Tu Anh: Conceptualization, Methodology, Data Analysis, Writing – Original Draft, Writing – Review & Editing, Supervision; Le Nguyen Phuc Linh: Methodology, Data Collection, Data Analysis, Writing – Review & Editing; Pham Minh Hieu: Data Collection, Data Analysis, Writing – Review & Editing.

Competing Interest

The authors declare no competing interests.

Data Availability

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

AI Use Declaration

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language editing, grammar correction, and improving the clarity and readability of the manuscript. All AI-assisted content was carefully reviewed and verified by the authors. The authors take full responsibility for the accuracy, integrity, and scientific content of the manuscript.

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