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# Driving Supply Chain Performance through Digitalization, Integration and Resilience in Manufacturing Firms

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**Abstract**

Global complexities and operational disruptions pose significant challenges to modern logistics networks, making efficient supply chain management critical to firm survival. This study examines the impact of supply chain digitalization on supply chain performance. While digitalization is vital, its direct value remains debated; this research uniquely investigates how organizational integration and resilience simultaneously channel and maximize these digital benefits within a unified framework. A quantitative design was employed, using a structured survey administered to 297 experienced supply chain professionals at medium- and large-sized manufacturing firms in Batam City. The empirical findings reveal that supply chain digitalization directly boosts performance and yields significant indirect impacts through partial mediation. Specifically, digital adoption enhances supply chain integration, which in turn strengthens supply chain resilience, thereby ensuring operational stability and recovery capacity during crises. Implicationally, digital tools do not act in isolation but function as a technological backbone that requires integrated structures and resilient designs to unlock optimal value. It is highly recommended that logistics managers prioritize connective, cloud-based technologies and strategic partner collaboration rather than deploying isolated software solutions.

**Keywords:** Digitalization; Integration; Resilience; Supply Chain Performance.

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## INTRODUCTION

Global complexity and the increasing dependence on digital technology have forced modern manufacturing firms to navigate significant hurdles in managing their supply chains efficiently and sustainably (Piprani et al., 2024). In today's interconnected markets, digitalization has emerged as a key strategic tool to enhance operational visibility, optimize resource efficiency, and accelerate decision-making speeds within logistics systems (Bag et al., 2020). Technologies such as big data, cloud computing, and integrated information software allow firms to capture real-time insights and streamline cross-functional workflows, making digital transformation an essential asset for organizational competitiveness.

However, building a digitally advanced supply chain is increasingly difficult due to a highly volatile global environment. Geopolitical instability, unpredictable demand fluctuations, and geographic fragmentation across global suppliers leave logistics networks highly vulnerable to severe operational disruptions (Ivanov, 2021). Supply chains spread across various geographic locations render the management of goods and information flows progressively harder to oversee and increasingly susceptible to disruptions (Ghoubach & El Amine, 2025). The lingering lessons from the COVID-19 pandemic clearly demonstrated the catastrophic impacts of such disruptions, ranging from raw material shortages to severe distribution delays, all of which threaten business continuity (Thompson, 2025). Past studies emphasize that many manufacturing companies fail to respond adaptively to these crises due to weak logistical responsiveness and a profound lack of supply chain visibility (Ghoubach & El Amine, 2025).

This phenomenon exposes a critical gap in practice and literature: supply chain efficiency and superior performance cannot be achieved through digitalization alone. Implementing advanced technologies does not automatically guarantee success if a firm lacks organizational readiness or fails to couple technology with strategic risk management (Kong & Feng, 2025). While many businesses invest heavily in isolated digital tools, these investments fail to deliver maximum value because they overlook the vital roles of process integration and resilience strategies in navigating market uncertainties (Chen, 2025).

To survive this volatile operational landscape, strengthening supply chain resilience and strategically driving supply chain integration have become immediate imperatives. Integration acts as the "digital glue" that harmonizes data exchange and collaboration among logistics partners. At the same time, resilience provides the core capability to anticipate, withstand, and quickly recover from unexpected shocks through data-driven assistance and digitally integrated systems. Tools such as big data analytics, blockchain, and information systems integration have demonstrated their ability to promote transparency while improving the agility and robustness of supply chains. In addition to resilience, integrating the supply chain plays a crucial role in ensuring that adopted digital tools effectively foster alignment and harmony among the parties involved in logistics chains. Such integration promotes seamless data exchange and productive teamwork, thereby bolstering supply chain effectiveness amid unpredictability (Siddiqui et al., 2025).

Based on these pressing motives, this research aims to address the direct and indirect pathways of technology adoption. Although the individual relationships among digitalization, integration, and resilience have been documented, a critical research gap persists in understanding how these dimensions interact to drive supply chain performance within a unified framework. Prior studies frequently treat digitalization as a direct driver of performance, yielding fragmented or inconsistent conclusions because they overlook the structural and dynamic capabilities necessary to absorb technological benefits. This study addresses this theoretical oversight and establishes its novelty by empirically analyzing the sequential mediating effects of Supply Chain Integration and Supply Chain Resilience in linking Supply Chain Digitalization to Supply Chain Performance. By doing so, the investigation moves beyond examining the immediate impacts of digitalization to uncover the precise mechanism through which digital tools transform operational structures into dynamic, resilient capabilities. Consequently, the results of this work are expected to expand the body of knowledge in strategic supply chain management and provide actionable, empirical guidance for manufacturing firms navigating digital transformation in highly volatile markets.

## LITERATURE REVIEW

In contemporary strategic management literature, understanding the underlying determinants of Supply Chain Performance requires a comprehensive multi-theoretical lens that accounts for both static resources and dynamic operational environments. Notably, this framework is heavily grounded in the Resource-Based View (RBV) theory, which posits that firms achieve superior performance through unique bundles of corporate resources and capabilities that are valuable, rare, inimitable, and organized effectively (Barney, 1991). In the highly volatile context of modern logistics, this perspective seamlessly extends to the Dynamic Capabilities Theory, emphasizing the firm's strategic ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing macro-environments (Teece et al., 1997). Collectively, these foundational theories underscore that digitalization, process integration, and structural resilience do not operate in isolation but rather constitute critical, mutually reinforcing capabilities that drive and sustain optimal supply chain performance.

### Supply Chain Performance

Supply chain performance is comprehensively evaluated through a balanced set of operational metrics, including cost efficiency, delivery speed, service accuracy, and structural adaptability to shifting market demands (Z. Wang, Geng, et al., 2025). Fundamentally, achieving superior performance depends heavily on continuous product availability and secure, damage-free delivery systems (Lee, Romzi, et al., 2022). Operational evaluations of supply chain performance track critical execution factors such as inventory turnover velocity, on-time delivery accuracy, and the cash-to-cash cycle time—which measures the precise duration from cash outlay for raw materials to cash receipt from end (Lee, Azmi, et al., 2022). The strategic application of lean principles within operational systems has been empirically proven to enhance structural stability, smooth the flow of goods, and optimize the efficiency of logistical processes (Prakash & Dhingra, 2025). Moreover, the deployment of advanced digital technologies strengthens cross-functional coordination across supply chain tiers while fostering highly responsive, agile decision-making frameworks (Alaminos & Guillén-Pujadas, 2025). Additionally, the use of data-driven key performance indicators, combined with machine learning algorithms, helps contemporary firms monitor end-to-end system effectiveness in real time (Ghadiri Khorzoughi et al., 2025).

### Supply Chain Digitalization

Supply chain digitalization refers to the strategic deployment of digital technologies to interconnect all business processes within a logistics network, enabling real-time operations and automated workflows (Alaminos & Guillén-Pujadas, 2025). This digital transformation encompasses the integration of cloud-based software, big data analytics, and artificial intelligence to maximize operational efficiency and enhance overall visibility across the logistics pipeline (S. K. Cho et al., 2025). To achieve comprehensive digitalization, firms must introduce cutting-edge technologies alongside crucial supporting pillars, such as digital strategies, digital organizational frameworks, a digitally oriented culture, and digital talent (Li et al., 2022). Furthermore, digital leadership and organizational capabilities in technology adoption play a crucial role in accelerating cross-functional digitalization, including cross-border trade operations (Z. Wang, Pan, et al., 2025). Digitalization strategies designed through a collaborative approach have been shown to expand adaptive capacity to shifting market demands while minimizing the risk of operational disruptions (Jing & Fu, 2026). In the current digital era, the use of digital services and advanced analytical algorithms within supply chains is essential for firms to sustain a robust competitive advantage (Ivanov, 2021).

### Supply Chain Integration

Supply chain integration (SCI) refers to the extent to which an organization's internal cross-functional processes and external operations—spanning suppliers, customers, and other supply chain partners—are systematically interconnected to enable efficient flows of information and materials (Bodendorf et al., 2023; Cheng et al., 2022). Technology-driven integration, facilitated by advanced digital platforms and big data architectures, significantly strengthens collaborative capabilities among business partners in the face of global disruptions (M. Wang, 2025). Understanding the distinct dimensions of SCI is vital to unpacking how each dimension influences operational performance and how these elements interact (Tan et al., 2023). By tightly linking internal operations with external suppliers and customers across the broader logistics network, firms can realize substantial strategic performance outcomes (Espino-Rodríguez & Taha, 2022). Ultimately, the implementation of strategic integration within logistics management not only fortifies supply chain resilience but also sharply elevates firm responsiveness toward volatile market dynamics (Alaminos & Guillén-Pujadas, 2025).

### Supply Chain Resilience

Supply chain resilience (SCR) is widely regarded as a fundamental core competency for addressing and navigating disruptive incidents within global trade channels (Vanany et al., 2024). In modern logistics networks, resilience refers to the strategic capacity of a logistics framework to effectively anticipate, respond to, and recover from unforeseen operational disturbances (Huan et al., 2025). In practice, firms with high resilience can sustain operational stability and ensure reliable deliveries even amid severe crises (Wagude, 2025). Consequently, enhancing SCR helps organizations become better prepared for disruptions, significantly reduces systemic vulnerabilities, and safeguards long-term business continuity (Vali-Siar & Roghanian, 2022). Strategic efforts to build organizational resilience encompass the deep integration of information systems, proactive supplier diversification, and the utilization of predictive analytical technologies for real-time risk monitoring (Shekarabi et al., 2025). Furthermore, establishing collaborative alliances with strategic external partners has been proven to accelerate supply chain recovery and minimize the compounding impacts of disruptions (S. K. Cho et al., 2025).

### The Effect of Supply Chain Digitalization on Supply Chain Integration

Digitalization within the supply chain enables seamless synchronization across functional areas and business partners through interconnected information systems, thereby supporting efficient cross-organizational coordination (Vu et al., 2025). Empirical studies demonstrate that cutting-edge technologies—such as blockchain, Enterprise Resource Planning (ERP), and big data analytics—significantly strengthen the real-time cohesion of production, distribution, and inventory management processes (Y. S. Cho et al., 2025). Furthermore, digital technologies serve as a primary connective infrastructure among supply chain entities, thereby elevating both vertical and horizontal integration in logistics operations (Agafonova et al., 2020). A high level of digital maturity further consolidates the strategic relationships between firms and their external partners within a singular, integrated ecosystem (L. Yang et al., 2025). Additionally, the profound impact of digitalization on supply chain integration is reflected in enhanced responsiveness and coordination capabilities during joint decision-making processes (Taghipour et al., 2022). Based on these collective theoretical arguments, this study proposes the following hypothesis:

$H_1$: Supply Chain Digitalization Positively and Significantly Influences Supply Chain Integration.

### The Effect of Supply Chain Digitalization on Supply Chain Resilience

Digital transformation has been empirically shown to be a vital catalyst for structuring resilient and adaptive supply chain frameworks capable of navigating operational disruptions (Weber et al., 2023). Advanced digital tools—including the Internet of Things (IoT), cloud computing, and big data analytics—enable organizations to monitor, respond swiftly, and proactively mitigate risks in real time (Ruan et al., 2025). Empirical research indicates that digitalization substantially expands flexibility, operational visibility, and collaborative decision-making capacities when confronting unexpected supply chain crises (S. K. Cho et al., 2025). Moreover, the implementation of digital supply networks supports companies in building robust recovery capacities and sustaining operational stabilization during times of disruption (Pu & Suo, 2025). Digital tools have also been shown to optimize logistical efficiency, reinforce coordination among strategic partners, and directly enhance an organization's overall resilience (Y. Yang & Zhang, 2025). Based on these robust arguments, this study proposes the following hypothesis:
$H_2$: Supply Chain Digitalization Positively and Significantly Influences Supply Chain Resilience.

### The Effect of Supply Chain Digitalization on Supply Chain Performance

Supply chain digitalization accelerates decision-making processes and enhances operational efficiency through process automation and real-time operational visibility (Seyedghorban et al., 2020). The strategic use of blockchain and the Internet of Things (IoT) enables lean management systems to operate more adaptively and responsively to volatile market demands (Y. S. Cho et al., 2025). Other empirical research indicates that digital integration within planning and distribution architectures increases service delivery speed while optimizing logistics cost control mechanisms (Morgado & Costa, 2025). Furthermore, digital technologies play a critical role in driving supply chain efficiency by strengthening end-to-end tracking capabilities and cross-border cargo management processes (Lehmacher, 2021). Additionally, digital networks have been empirically shown to improve demand forecasting accuracy and strengthen cross-functional coordination among distinct business units within the supply chain (Prakash & Dhingra, 2025). Based on these collective theoretical insights, this study proposes the following hypothesis:
$H_3$: Supply Chain Digitalization Positively and Significantly Influences Supply Chain Performance.

### The Effect of Supply Chain Integration on Supply Chain Resilience

A well-executed supply chain integration enhances visibility, operational flexibility, and organizational response capabilities when confronting severe operational disruptions (Yawalkar et al., 2023). When distinct entities across the supply chain network are systematically interconnected through integrated information and communication channels, they have a greater capacity to anticipate and mitigate operational risks (Choudhary et al., 2025). Other empirical evidence suggests that both upstream and downstream integration significantly contribute to the development of adaptive resilience structures capable of withstanding global supply shocks (Qi et al., 2023). Moreover, investments in supply chain system integration have been proven to fortify operational stability and boost export resilience by enhancing technological visibility and partner coordination (Munir et al., 2020). Finally, internal process integration fosters faster, more collaborative decision-making frameworks, which directly accelerate the organizational recovery process post-disruption (Siagian et al., 2021). Based on these robust arguments, this study proposes the following hypothesis:
$H_4$: Supply Chain Integration Positively and Significantly Influences Supply Chain Resilience.

### The Effect of Supply Chain Integration on Supply Chain Performance

Supply chain integration directly enhances operational efficiency by reducing processing times, improving planning accuracy, and minimizing distribution costs (Masa'deh et al., 2022). A supply chain integration approach rooted in lean principles and digitalization has been empirically shown to enhance process efficiency and drive overall performance improvements in corporate operational settings (Alaminos & Guillén-Pujadas, 2025). Furthermore, strategic collaboration among supply chain partners accelerates firms' responsiveness to market dynamics, thereby improving service delivery speed and operational flexibility (Nguyen et al., 2025). In the manufacturing context, the simultaneous deployment of internal and external integration effectively elevates collaborative efficiency and mitigates operational disruption risks (Munir et al., 2020). Integration strategies within supply chain management also accelerate technology adoption and foster continuous innovations that positively impact long-term performance (Choudhary et al., 2025). From a Resource-Based View (RBV) perspective, supply chain integration helps firms acquire valuable, imperfectly imitable resources and capabilities, ultimately elevating their competitive performance (Erboz et al., 2022). Based on these collective theoretical insights, this study proposes the following hypothesis:
$H_5$: Supply Chain Integration Positively and Significantly Influences Supply Chain Performance.

### The Effect of Supply Chain Resilience on Supply Chain Performance

Resilience within the supply chain elevates operational performance by reinforcing organizational capabilities to withstand disruptions and efficiently restore standard operations (Zhixin et al., 2025). Building resilience supports supply chain performance stability during unexpected shocks by enhancing partner collaboration, flexibility, and overall network robustness (Juan et al., 2022). Additionally, supply chain resilience significantly strengthens sustainability performance and operational efficiency in manufacturing sectors by stabilizing supply and enhancing demand responsiveness (Choudhary et al., 2025). Prior research confirms that a resilient logistics ecosystem successfully improves delivery accuracy, shortens lead times, and sustains service quality within highly dynamic business environments (Gao et al., 2025). Finally, probabilistic model analyses indicate that firms with higher resilience exhibit significantly superior overall supply chain performance (Alaminos & Guillén-Pujadas, 2025). If the inbound material flow from suppliers is disrupted, end-to-end supply chain operations will stall, preventing the fulfillment of customer demands; hence, enhancing SCR serves as an essential foundational step to maximize supply chain performance (Gu et al., 2021). Based on these robust arguments, this study proposes the following hypothesis:

$H_6$: Supply Chain Resilience Positively and Significantly Influences Supply Chain Performance.

### The Mediating Role of Supply Chain Integration

Digital transformation within the supply chain network has emerged as a critical strategy to enhance operational efficiency and achieve a sustainable competitive advantage. However, the foundational impact of digitalization on organizational performance is often indirect, flowing instead through specific internal coordination mechanisms such as supply chain integration (Wan et al., 2025). Supply chain integration (SCI) reflects the precise extent to which an organization successfully aligns its internal cross-functional processes and establishes highly effective collaboration with external suppliers and customers (Munir et al., 2020). In this context, digitalization actively drives integration by strengthening data-exchange infrastructure, accelerating decision-making cycles, and maximizing visibility across the end-to-end supply chain network (Putra et al., 2025). Extensive empirical studies demonstrate that SCI significantly mediates the relationship between digitalization and performance outcomes, particularly in highly digitalized sectors such as port operations, manufacturing, and commercial retail (Oubrahim et al., 2023). SCI serves as an essential structural bridge that translates raw digital technology capabilities into tangible performance milestones, including enhanced delivery accuracy, accelerated production rates, and substantial reductions in total operational costs (Ganbold et al., 2021). This theoretical pathway is firmly supported by both the Resource Orchestration Theory and the Information Processing Theory, which collectively emphasize that process integration is an absolute necessity for maximizing the strategic value derived from technological assets (Wamba et al., 2020). Based on these compounding insights, this study proposes the following hypothesis:

$H_7$: Supply Chain Integration Positively and Significantly Mediates the Influence of Supply Chain Digitalization on Supply Chain Performance.

### The Mediating Role of Supply Chain Resilience

The advancement of digital technology is a primary catalyst for building a robust supply chain resilience framework, ultimately contributing positively to a firm's operational and strategic performance metrics (Hazam & Ouhna, 2025). Digital transformation equips contemporary organizations with the capacity to develop sophisticated early-detection systems, rapid crisis-response frameworks, and efficient recovery mechanisms to address unexpected supply chain disruptions (Mrad & Belgaroui, 2025). Empirical research indicates that organizations that successfully integrate their digital architectures with structured resilience strategies achieve superior performance enhancements, spanning cost efficiency, delivery velocity, and operational adaptability (Putra et al., 2025). Furthermore, achieving a high degree of digital maturity significantly fortifies a firm's structural resilience when navigating systemic crises, thereby mitigating the severe downstream consequences of broader market disruptions (He et al., 2023). Firms utilizing advanced digital twins and predictive analytics architectures successfully create exceptional supply chain visibility and flexibility, thereby maximizing the positive impacts of digitalization on overall performance by cultivating structural resilience (Alaminos & Guillén-Pujadas, 2025). Based on these robust theoretical arguments, this study proposes the following hypothesis:

$H_8$: Supply Chain Resilience Positively and Significantly Mediates the Influence of Supply Chain Digitalization on Supply Chain Performance.

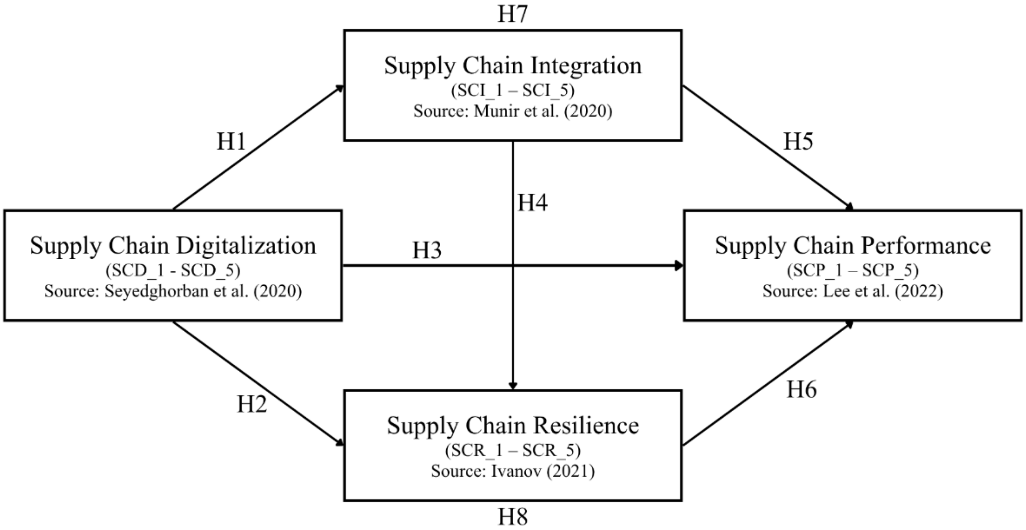


**Figure 1.** Conceptual Research Model

## METHOD

This study adopts a rigorous quantitative research design, using a structured survey administered electronically via Google Forms. A quantitative method was selected because it provides a systematic framework for testing hypothesized relationships among operational constructs using numerical data and advanced statistical analysis (Sekaran & Bougie, 2016). The primary empirical objective is to examine and validate the direct and indirect pathways of interconnection among supply chain digitalization, supply chain integration, supply chain resilience, and corporate supply chain performance. The empirical focus of this investigation is on medium- and large-scale manufacturing enterprises operating within the strategic industrial zone of Batam City, Riau Islands Province. The comprehensive data collection process was systematically conducted over three months, from January to March 2025.

The target population of this study encompasses 614 manufacturing companies officially registered under the Large and Medium Industries category by the Central Bureau of Statistics (BPS) of Riau Islands Province in 2024. To select an accurate and highly representative sample from this population, a non-probability purposive sampling technique was applied. The purposive selection criteria strictly required that respondents be professionals directly involved in corporate supply chain management operations, including logistics managers, operational supervisors, and specialized supply chain staff (Sugiyono, 2019; Sekaran & Bougie, 2016). To determine the appropriate minimum sample size to ensure statistical power, the Slovin formula was applied with a strict 5% margin of error, yielding a minimum baseline threshold of 242 respondents based on a total population of 614 companies (Umar, 2008). To proactively mitigate potential non-response rates or incomplete submissions, the survey was distributed to a broader pool of eligible supply chain practitioners. Through this expanded dissemination effort, a total of 297 fully completed and valid responses were successfully retrieved and retained for the final analytical framework. This final sample size of 297 exceeds the minimum Slovin requirement, thereby enhancing the overall statistical power and generalizability of the structural path estimates.

The primary research instrument consisted of a closed, highly structured questionnaire comprising 20 distinct measurement items. Respondents evaluated each item using a five-point Likert scale structure, ranging from 1 (strongly disagree) to 5 (strongly agree). Each measurement item was adapted from robust indicators previously validated in the supply chain literature and carefully tailored to the specific context of this empirical framework (Malhotra, 2010; Sugiyono, 2019).

The collected data were systematically analyzed through a comprehensive two-stage statistical process. In the first stage, descriptive statistical analyses were conducted using IBM SPSS Statistics 27 to examine respondent profiles and general data distributions. In the second stage, a structural equation framework was evaluated using a Partial Least Squares Structural Equation Modeling (PLS-SEM) approach in SmartPLS 3. The PLS-SEM technique is a state-of-the-art methodology chosen for its exceptional ability to handle highly complex structural path configurations, achieve robust estimates with realistic sample sizes, and operate effectively without requiring rigid assumptions about the normality of the data (Hair et al., 2021).

The measurement evaluation framework was thoroughly divided into two fundamental phases. First, the measurement model (outer model) was rigorously assessed for internal consistency, reliability, and validity using composite reliability (CR), average variance extracted (AVE), and the Heterotrait-Monotrait (HTMT) ratio. Second, the structural model (inner model) was evaluated by testing path coefficients, coefficients of determination ($R^2$), and model fit indicators via the Standardized Root Mean Square Residual (SRMR). To proactively mitigate the potential risks of common method bias (CMB), a comprehensive collinearity-based test was conducted by examining variance inflation factor (VIF) metrics at the construct level. Finally, the statistical significance of both the direct and indirect mediating paths was assessed using a nonparametric bootstrapping procedure with 5,000 subsamples at a strict 5% significance level (Sarstedt et al., 2014; Hair et al., 2021).

To evaluate the hypothesized structural relationships (H1 through H8), a formal hypothesis-testing procedure was conducted using the bootstrapping outputs. The statistical significance of each path coefficient was determined using two-tailed critical values at a strict 5% significance level. Specifically, adhering to the established methodological criteria in this framework (Hair et al., 2021; Sarstedt et al., 2014), a hypothesis is statistically accepted if the resulting empirical T-statistic exceeds the critical threshold of 1.96 ($t > 1.96$). The corresponding P-value is lower than the standard significance threshold of 0.05 ($p < 0.05$). Conversely, paths failing to meet these simultaneous parameters are classified as statistically non-significant, leading to the rejection of the hypothesis. For the indirect mediation effects (H7 and H8), significance was cross-validated using the specific indirect path's T-statistics and 95th percentile confidence intervals generated with the same bootstrapping configuration (Hair et al., 2021), ensuring a structurally coherent validation framework for all hypothesized impacts.

## RESULT

### Characteristics of Respondents

A total of 297 respondents successfully participated and completed the survey in this study. In terms of gender distribution, the majority of the participants were male (63.0%), while female respondents accounted for 37.0%. Regarding the age profile, the sample was heavily dominated by individuals in the 30–39 age bracket (44.8%), followed by the 18–29 age bracket (21.2%) and the 40–49 age bracket (20.9%).

In terms of educational background, a substantial proportion of respondents held a Bachelor's degree (46.8%) and a Master's degree (26.9%), with the remaining participants comprising Diploma holders (18.5%), High School graduates (6.4%), and Doctoral degree holders (1.3%). With respect to organizational job positions, the largest share was among specialized staff (33.7%), followed closely by lower-level management (32.3%) and middle-level management (24.6%). In comparison, top-level executive management accounted for 9.4% of the sample.

Looking at the institutional profiles of the enterprises, most respondents were employed at manufacturing firms established for more than 9 years (40.1%). In terms of organizational scale, these companies primarily employed between 500 and 1,000 employees (38.4%) and over 1,000 employees (30.3%). Finally, regarding professional tenure, the majority of respondents had more than 10 years of work experience (43.8%), followed by those with 5–10 years of tenure (33.0%) and those with less than 5 years of professional experience (23.2%).

### Descriptive Statistical Analysis

Descriptive statistics were used to assess the general characteristics and distributions of the research variables. The summarized output of the descriptive analysis for each construct is presented in Table 1.

**Table 1.** Descriptive Statistics of Variables

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Supply Chain Digitalization | 297 | 5.00 | 25.00 | 15.283 | 5.059 |
| Supply Chain Integration | 297 | 5.00 | 24.00 | 15.293 | 4.234 |
| Supply Chain Resilience | 297 | 6.00 | 23.00 | 15.067 | 3.692 |
| Supply Chain Performance | 297 | 5.00 | 25.00 | 15.296 | 4.247 |
| Valid N (listwise) | 297 | | | | |

Based on the descriptive statistics, the mean values for all constructs fall within a tight range of 15.067 to 15.296, with relatively moderate standard deviations. This distribution indicates that the respondents' perceptions regarding digitalization, integration, resilience, and performance within their respective supply chains are fairly high and exhibit a consistent pattern. The highest mean value is recorded for the Supply Chain Performance variable (15.296), indicating that the majority of respondents perceive their organizations' supply chain execution as highly optimal. Conversely, Supply Chain Resilience exhibits the lowest mean score (15.067). This lower average implies that while the overall perception of resilience is fundamentally sound, this specific domain still possesses substantial room for improvement, particularly in strengthening the firm's adaptive capacity to withstand and absorb unexpected supply chain disruptions.

### Common Method Bias Test

To proactively address potential method variance in self-reported survey data, a Common Method Bias (CMB) assessment was executed. Following the full collinearity testing approach recommended by Kock (2015), a structural model is considered entirely free from severe CMB if the latent inner Variance Inflation Factor (VIF) values remain strictly below the threshold of 3.3. The empirical VIF calculations are detailed in Table 2.

**Table 2.** VIF Results for Common Method Bias

| | Supply Chain Digitalization | Supply Chain Integration | Supply Chain Performance | Supply Chain Resilience |
|---|---|---|---|---|
| Supply Chain Digitalization | | 1.000 | 2.322 | 2.259 |
| Supply Chain Integration | | | 2.989 | 2.259 |
| Supply Chain Performance | | | | |
| Supply Chain Resilience | | | 2.112 | |

The empirical results from the full collinearity test indicate that the VIF values for all examined latent constructs range from 1.000 to 2.989, remaining well below the conservative 3.3 benchmark. These statistical findings systematically confirm that the empirical model is not contaminated by significant common method bias. Consequently, the data set meets the rigorous requirements for systemic validity, making it highly suitable for subsequent measurement and structural model evaluations.

## Measurement Model Evaluation (Outer Model)

The measurement model was thoroughly evaluated to confirm the internal consistency, reliability, convergent validity, and discriminant validity of the reflective constructs prior to conducting structural path analyses.

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

| Latent Variable | Items | Outer Loadings | AVE | Composite Reliability | Cronbach's Alpha |
|---|---|---|---|---|---|
| Supply Chain Digitalization | SCD_1 | 0.886 | 0.762 | 0.941 | 0.922 |
| | SCD_2 | 0.879 | | | |
| | SCD_3 | 0.887 | | | |
| | SCD_4 | 0.865 | | | |
| | SCD_5 | 0.847 | | | |
| Supply Chain Integration | SCI_1 | 0.828 | 0.642 | 0.900 | 0.861 |
| | SCI_2 | 0.807 | | | |
| | SCI_3 | 0.801 | | | |
| | SCI_4 | 0.778 | | | |
| | SCI_5 | 0.792 | | | |
| Supply Chain Performance | SCP_1 | 0.847 | 0.672 | 0.911 | 0.878 |
| | SCP_2 | 0.822 | | | |
| | SCP_3 | 0.788 | | | |
| | SCP_4 | 0.813 | | | |
| | SCP_5 | 0.830 | | | |
| Supply Chain Resilience | SCR_1 | 0.734 | 0.591 | 0.878 | 0.826 |
| | SCR_2 | 0.735 | | | |
| | SCR_3 | 0.777 | | | |
| | SCR_4 | 0.810 | | | |
| | SCR_5 | 0.784 | | | |

As shown in Table 3, all measurement items have outer loadings well above the minimum statistical threshold of 0.708 recommended by Hair et al. (2021). This verifies that each reflective indicator contributes a significant and consistent proportion of variance to its respective latent construct. Furthermore, the Average Variance Extracted (AVE) values across all four latent constructs surpass the 0.500 benchmark originally established by Fornell & Larcker (1981). This standard indicates that the target construct explains a greater share of the indicator variance than the lingering error variance. Consequently, convergent validity for the outer measurement model is systematically established.

Construct reliability metrics further substantiate the quality of the measurement framework. Every latent construct exhibits a Cronbach's Alpha value higher than 0.70, satisfying the conservative internal consistency criteria proposed by Hair et al. (2021). This reliability is strongly supported by the Composite Reliability (CR) scores, which comfortably exceed the 0.70 threshold across all dimensions (Hair et al., 2021). These statistical metrics confirm that the empirical instruments exhibit optimal internal stability and reliability, thereby qualifying the dataset for subsequent structural model estimation.

**Table 4.** Discriminant Validity Results via Heterotrait-Monotrait (HTMT) Ratio

| Latent Variable | Supply Chain Digitalization | Supply Chain Integration | Supply Chain Performance | Supply Chain Resilience |
|---|---|---|---|---|
| Supply Chain Digitalization | | | | |
| Supply Chain Integration | 0.837 | | | |
| Supply Chain Performance | 0.767 | 0.813 | | |
| Supply Chain Resilience | 0.700 | 0.849 | 0.819 | |

Discriminant validity was rigorously evaluated using the Heterotrait–Monotrait (HTMT) ratio approach, which is the most sensitive and modern statistical criterion for diagnosing potential overlap among reflective latent constructs (Henseler et al., 2015). The empirical HTMT ratios, summarized in Table 4, range from 0.700 to 0.849, resting safely below the stringent conservative threshold of 0.90 proposed by Hair et al. (2021). These findings empirically demonstrate that each construct possesses sufficient statistical distinctiveness and is conceptually unentangled with other operational concepts within the model. With all measurement parameters validated, the research model is deemed eligible for inner model testing.

**Table 5.** Discriminant Validity Results via the Fornell-Larcker Criterion

| Latent Variable | Supply Chain Digitalization | Supply Chain Integration | Supply Chain Performance | Supply Chain Resilience |
|---|---|---|---|---|
| Supply Chain Digitalization | 0.873 | | | |
| Supply Chain Integration | 0.747 | 0.801 | | |
| Supply Chain Performance | 0.690 | 0.707 | 0.820 | |
| Supply Chain Resilience | 0.611 | 0.716 | 0.698 | 0.769 |

To complement the HTMT assessment, discriminant validity was further cross-examined utilizing the traditional Fornell-Larcker criterion. Under this methodological framework, discriminant validity is fully established when the square root of the AVE for each latent construct (presented along the bold diagonal) is higher than any correlation coefficients involving that specific construct in the corresponding rows and columns (Fornell & Larcker, 1981; Hair et al., 2021). The empirical findings documented in Table 5 demonstrate that all diagonal values—ranging from 0.769 to 0.873—surpass the off-diagonal correlation constructs in their respective rows and columns. This outcome consistently indicates that each construct is sufficiently distinct from the other variables. Consequently, the Fornell-Larcker criteria consistently corroborate that the outer measurement model satisfies the strict requirements of discriminant validity.

## Model Fit Evaluation

Model fit in the PLS-SEM approach was evaluated using the Standardized Root Mean Square Residual (SRMR). The SRMR quantifies the average standardized residual between the observed covariance matrix and the covariance matrix predicted by the structural model. An SRMR value below the threshold of 0.08 indicates an acceptable and good model fit (Hu & Bentler, 1999; Hair et al., 2021). The results of the model fit estimation are detailed in Table 6.

**Table 6.** Model Fit Results via Standardized Root Mean Square Residual (SRMR)

| | Saturated Model | Estimated Model |
|---|---|---|
| SRMR | 0.046 | 0.046 |

The statistical evaluation presented in Table 6 reveals that the SRMR values for both the saturated and estimated models are identical at 0.046, resting comfortably below the conservative 0.08 benchmark. This statistical configuration provides empirical evidence that the developed structural framework exhibits a highly adequate model fit and is robustly acceptable for subsequent hypothesis testing.

**Table 7.** Results of Goodness of Fit (GoF) Index

| Latent Variable | Average Variance Extracted (AVE) | R Square |
|---|---|---|
| Supply Chain Digitalization | 0.762 | |
| Supply Chain Integration | 0.642 | 0.557 |
| Supply Chain Performance | 0.672 | 0.616 |
| Supply Chain Resilience | 0.591 | 0.526 |
| Average | 0.667 | 0.566 |
| Average AVE*R Square ($R^2$) | 0.378 | |
| GoF ($\sqrt{AVE \times R\ Square}$) | 0.614 | |

The Goodness of Fit (GoF) index provides a holistic metric of the model's overall fit within the PLS-SEM framework. It serves as a complementary indicator that combines the quality of the measurement model, as assessed by the AVE, and the predictive power of the structural model, as assessed by $R^2$ (Tenenhaus et al., 2005). As documented in Table 7, the calculated average AVE is 0.667, and the average $R^2$ is 0.566, yielding an overall GoF of 0.614. According to the baseline criteria established by Wetzels et al. (2009), GoF index values are classified into three categories: small ($\geq 0.10$), medium ($\geq 0.25$), and large ($\geq 0.36$). Consequently, the empirical GoF value of 0.614 falls comfortably within the large category, confirming that the structural framework possesses strong global validity in explaining the interconnected relationships among the latent constructs.

## Structural Model Evaluation (Inner Model)

**Table 8.** Results of Coefficient of Determination (R Square)

| Latent Variable | R Square ($R^2$) | R Square Adjusted | Results |
|---|---|---|---|
| Supply Chain Integration | 0.557 | 0.556 | Moderate |
| Supply Chain Performance | 0.616 | 0.612 | Moderate |
| Supply Chain Resilience | 0.526 | 0.523 | Moderate |

The coefficient of determination ($R^2$) is used to evaluate the model's explanatory power by measuring the proportion of variance in the endogenous constructs explained by the exogenous constructs. Based on the criteria proposed by Hair et al. (2021), $R^2$ values of 0.75, 0.50, and 0.25 are categorized as substantial, moderate, and weak, respectively. The statistical outcomes presented in Table 8 indicate that Supply Chain Integration yields an $R^2$ value of 0.557, Supply Chain Performance yields an $R^2$ value of 0.616, and Supply Chain Resilience yields an $R^2$ value of 0.526. All three endogenous constructs fall into the moderate category, indicating that the structural model possesses adequate and meaningful explanatory capacity for the observed endogenous variables. Furthermore, the adjusted $R^2$ values are nearly identical to the standard $R^2$ values, indicating that the structural framework does not suffer from overfitting and exhibits optimal stability.

## Hypothesis Testing

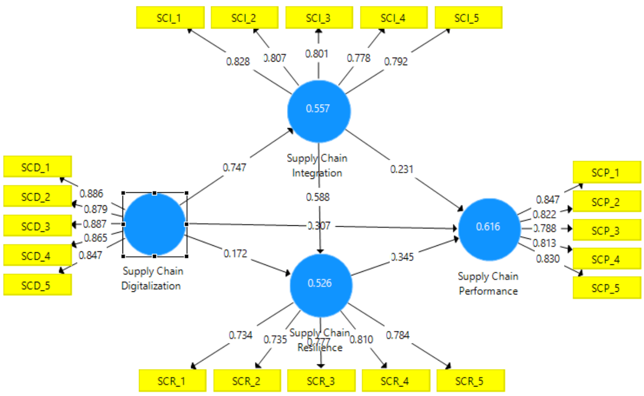


**Figure 2.** Bootstrapping

Hypothesis testing in this study was conducted within the PLS-SEM framework using a nonparametric bootstrapping procedure with 5,000 subsamples. Structural path relationships are classified as statistically significant if the p-values are < 0.05 and the t-statistics are> 1.96 (Hair et al., 2021). The empirical evaluation of the direct structural pathways is summarized in Table 9.

**Table 9.** Results of Direct Effect Hypotheses

| Hypotheses | | Original Sample (O) | Sample Mean (β) | Standard Deviation | T Statistics (t) | P Values (*p*) |
|---|---|---|---|---|---|---|
| $H_1$ | Supply Chain Digitalization > Supply Chain Integration | 0.747 | 0.747 | 0.026 | 28.675 | 0.000 |
| $H_2$ | Supply Chain Digitalization > Supply Chain Resilience | 0.172 | 0.172 | 0.061 | 2.830 | 0.005 |
| $H_3$ | Supply Chain Digitalization > Supply Chain Performance | 0.307 | 0.306 | 0.054 | 5.723 | 0.000 |

| Hypotheses | | Original Sample (O) | Sample Mean (β) | Standard Deviation | T Statistics (t) | P Values (*p*) |
|---|---|---|---|---|---|---|
| $H_4$ | Supply Chain Integration > Supply Chain Resilience | 0.588 | 0.589 | 0.057 | 10.303 | 0.000 |
| $H_5$ | Supply Chain Integration > Supply Chain Performance | 0.231 | 0.231 | 0.058 | 3.973 | 0.000 |
| $H_6$ | Supply Chain Resilience > Supply Chain Performance | 0.345 | 0.346 | 0.053 | 6.560 | 0.000 |

The empirical findings documented in Table 9 reveal that all direct pathways among the latent constructs are statistically significant. Supply Chain Digitalization exerts a strong, positive direct influence on Supply Chain Integration ($\beta = 0.747$, $t = 28.675$, $p < 0.001$), thereby supporting H1. It also demonstrates statistically significant positive effects on Supply Chain Resilience ($\beta = 0.172$, $t = 2.830$, $p = 0.005$) and Supply Chain Performance ($\beta = 0.307$, $t = 5.723$, $p < 0.001$), thereby validating H2 and H3, respectively.

Furthermore, Supply Chain Integration has a substantial and statistically significant direct impact on Supply Chain Resilience ($\beta = 0.588$, $t = 10.303$, $p < 0.001$) and Supply Chain Performance ($\beta = 0.231$, $t = 3.973$, $p < 0.001$), thereby systematically validating H4 and H5. Lastly, Supply Chain Resilience displays a significant positive direct effect on Supply Chain Performance ($\beta = 0.345$, $t = 6.560$, $p < 0.001$), confirming H6. Consequently, all proposed direct hypotheses within the structural model are empirically supported.

To examine the indirect mechanisms linking technological adoption to performance outcomes, the specific indirect effects were evaluated. The empirical results of the mediation analysis are detailed in Table 10.

**Table 10.** Results of Indirect Effect Hypotheses (Mediation)

| Hypotheses | | Original Sample (O) | Sample Mean (β) | Standard Deviation | T Statistics (t) | P Values (*p*) |
|---|---|---|---|---|---|---|
| $H_7$ | Supply Chain Digitalization > Supply Chain Integration > Supply Chain Performance | 0.173 | 0.173 | 0.044 | 3.943 | 0.000 |
| $H_8$ | Supply Chain Digitalization > Supply Chain Resilience > Supply Chain Performance | 0.059 | 0.059 | 0.023 | 2.581 | 0.010 |

The mediation analysis utilizing the bootstrapping procedure with 5,000 subsamples confirms that both hypothesized indirect pathways are statistically significant. Supply Chain Digitalization indirectly influences Supply Chain Performance through the mediating channel of Supply Chain Integration ($\beta = 0.173$, $t = 3.943$, $p < 0.001$), validating H7. Similarly, the indirect relationship between Supply Chain Digitalization and Supply Chain Performance via Supply Chain Resilience is also statistically significant ($\beta = 0.059$, $t = 2.581$, $p = 0.010$), thereby validating H8.

Given that both the direct and indirect pathways remain simultaneously significant, it can be concluded that Supply Chain Integration and Supply Chain Resilience function as partial mediators within this structural framework (Hair et al., 2021; Zhao et al., 2010). These findings empirically demonstrate that internal process integration and organizational resilience are vital strategic mechanisms that transform raw digital technology investments into tangible improvements in overall corporate supply chain performance.

**Table 11.** Summary of Hypothesis Testing Results

| Code | Hypothesis | Path | Decision |
|---|---|---|---|
| $H_1$ | Supply Chain Digitalization positively influences Supply Chain Integration. | SCD > SCI | Supported |
| $H_2$ | Supply Chain Digitalization positively influences Supply Chain Resilience. | SCD > SCR | Supported |
| $H_3$ | Supply Chain Digitalization positively influences Supply Chain Performance. | SCD > SCP | Supported |
| $H_4$ | Supply Chain Integration positively influences Supply Chain Resilience. | SCI > SCR | Supported |
| $H_5$ | Supply Chain Integration positively influences Supply Chain Performance. | SCI > SCP | Supported |
| $H_6$ | Supply Chain Resilience positively influences Supply Chain Performance. | SCR > SCP | Supported |

| Code | Hypothesis | Path | Decision |
|---|---|---|---|
| $H_7$ | Supply Chain Integration mediates the influence of Supply Chain Digitalization on Supply Chain Performance. | SCD > SCI > SCP | Supported (Partial Mediation) |
| $H_8$ | Supply Chain Resilience mediates the influence of Supply Chain Digitalization on Supply Chain Performance. | SCD > SCR > SCP | Supported (Partial Mediation) |

A rigorous comparative analysis of the structural paths reveals that internal organizational structures largely mediate the overall impact of technology deployment on corporate performance. Specifically, the direct effect of Supply Chain Digitalization on Supply Chain Performance yields a path coefficient of β = 0.307 (t = 5.723, $p < 0.001$), supporting the base arguments of Seyedghorban et al. (2020). Interestingly, when evaluated against the indirect pathways, the combined indirect effect channeled through the twin mediators equals β = 0.232, comprising H7 (β = 0.173) via integration and H8 (β = 0.059) via resilience. This structural arrangement produces a variance accounted for (VAF) distribution where approximately 43% of digitalization's overall performance benefits are derived indirectly. Following the standard mediation rules established by Hair et al. (2021) and Zhao et al. (2010), the higher path coefficient of the direct path (β = 0.307) versus the individual indirect channels establishes that while digital tools retain standalone operational value, their strategic efficacy is profoundly amplified when paired with collaborative, adaptive organizational configurations (Alaminos & Guillén-Pujadas, 2025; Wan et al., 2025).

Furthermore, a deep dive into the specific indirect channels shows that Supply Chain Integration serves as a significantly stronger mediator (β = 0.173, t = 3.943) than standalone Supply Chain Resilience (β = 0.059, t = 2.581). This substantial coefficient gap implies that process alignment and cross-functional synchronization are the primary structural conduits through which digital investments translate into actual execution metrics (Bodendorf et al., 2023; Ganbold et al., 2021). In fact, the model highlights a cascading operational logic: digitalization strongly drives integration (β = 0.747, t = 28.675), which then serves as the primary precursor to fortifying resilience (β = 0.588, t = 10.303), a mechanism that aligns with Munir et al. (2020). Consequently, attempting to build a resilient network without establishing a digitally unified integration framework yields inferior performance outcomes (Putra et al., 2025).

## Managerial Implication

From a strategic decision-making perspective, these empirical comparisons provide a vital blueprint for logistics directors and executive leadership operating within Batam City's strategic industrial zone. First, corporate capital allocation should shift away from the isolated procurement of transactional software and instead prioritize deploying collaborative, cloud-based ERP architectures and automated data-sharing pipelines (Bag et al., 2020; Piprani et al., 2024). Because Supply Chain Integration has the highest mediating coefficient, managers must use digital tracking tools to enable deep, real-time information sharing and synchronization with external suppliers and customers (Laulita, 2021; Tan et al., 2023). This ensures that real-time data flows are immediately converted into cross-functional efficiency, short distribution cycles, and minimized logistics overheads (Masa'deh et al., 2022).

Second, the confirmation of partial mediation means that executives cannot treat resilience as a reactive, manual crisis-management department (He et al., 2023). Since Supply Chain Resilience directly impacts performance (β = 0.345) and serves as an essential channel for technology adoption, operations managers must proactively leverage predictive big data analytics and real-time risk-monitoring metrics (Ivanov, 2021; Kong & Feng, 2025). Manufacturing firms in Batam must actively transition toward data-driven early-warning systems to sustain delivery precision, reduce systemic vulnerabilities, and protect long-term operational continuity during volatile global supply market disruptions (Siddiqui et al., 2025; Vali-Siar & Roghanian, 2022). Ultimately, long-term supply network competitiveness cannot be achieved by mere technological adoption; it demands a deliberate corporate strategy that synthesizes raw data visibility with highly integrated workflows and agile structural defenses (Lee, Romzi, et al., 2022; Z. Wang, Pan, et al., 2025).

# DISCUSSION

## Supply Chain Digitalization on Supply Chain Integration

The empirical results of the structural model evaluation indicate that supply chain digitalization exerts a strong, positive, and statistically significant direct influence on supply chain integration. This relationship is rigorously supported by the primary data findings, which yield a path coefficient (β) of 0.747, a remarkably high t-statistic of 28.675, and a $p$-value of less than 0.001. These specific statistical values provide definitive mathematical validation that, as a manufacturing firm scales up its digital transformation infrastructure, its capacity for seamless cross-functional and inter-organizational integration expands concurrently.

In the specific operational context of the manufacturing sector in Batam City, this finding demonstrates that the aggressive deployment of digital technologies allows internal departments and external logistics partners to dissolve functional silos and bind fragmented operational processes. This outcome strongly reinforces the core arguments of Resource Orchestration Theory, confirming that digital connectivity acts as a mandatory capability rather than an isolated asset for achieving seamless alignment. This empirical finding directly aligns with the scholarly insights of Vu et al. (2025) and Y. S. Cho et al. (2025), who argued that architectures such as enterprise resource planning (ERP) systems and big data analytics significantly strengthen real-time cohesion and data synchronization in modern manufacturing environments.

## Supply Chain Digitalization on Supply Chain Resilience

The statistical analysis systematically confirms that supply chain digitalization has a positive and significant direct effect on supply chain resilience. The bootstrapping procedure generated a path coefficient (β) of 0.172, supported by a statistically robust t-statistic of 2.830 and a p-value of 0.005. Since the t-statistic comfortably exceeds the critical threshold of 1.96 and the p-value is well below the 0.05 alpha level, the empirical data provide strong evidence that technology adoption directly builds a firm's capacity to absorb external disruptions.

This baseline score demonstrates that digital transformation plays a proactive, critical role in shaping a manufacturing firm's risk architecture within highly volatile markets. Grounded in Information Processing Theory, data abundance successfully reduces environmental uncertainty by equipping manufacturing networks with superior predictive visibility. This localized industrial result is highly consistent with the conceptualizations of Weber et al. (2023) and Ruan et al. (2025), which collectively asserted that advanced digital infrastructures empower organizations to continuously monitor, swiftly respond to, and proactively mitigate unexpected operational shocks before they cascade through the logistics pipeline.

## Supply Chain Digitalization on Supply Chain Performance

Based on the structural path estimation, the empirical findings validate that supply chain digitalization positively and significantly influences corporate supply chain performance. The primary data registers a significant direct path coefficient (β) of 0.307, paired with a high t-statistic of 5.723 and a p-value of less than 0.001. This mathematical configuration indicates that investments in technology directly generate measurable improvements in structural output, independent of external mediating mechanisms.

This specific metric indicates that capital allocation for digital tools successfully accelerates organizational decision-making and sharply enhances operational efficiency through automated workflows and end-to-end transparency. This structural outcome strongly supports the earlier empirical assertions by Seyedghorban et al. (2020) and Y. S. Cho et al. (2025), in which the targeted use of blockchain and Internet of Things (IoT) technologies enables lean manufacturing systems to operate in a highly adaptive manner. Furthermore, these findings closely align with the real-world operational models of Morgado & Costa (2025) and Prakash & Dhingra (2025), demonstrating that digital tracking architectures optimize service delivery speed and foster tighter logistics cost control.

## Supply Chain Integration on Supply Chain Resilience

The empirical data gathered from manufacturing professionals clearly demonstrate that supply chain integration has a major, positive, and significant direct impact on supply chain resilience. This structural pathway displays an original sample path coefficient (β) of 0.588, which is anchored by a highly substantial t-statistic of 10.303 and a p-value of less than 0.001. The sheer magnitude of this t-statistic underscores that connective integration is one of the single most powerful internal drivers of risk preparedness within the model.

This finding confirms that deep internal and external coordination among logistical partners serves as a vital structural prerequisite for building operational flexibility. When distinct corporate business units and supply chain partners are systematically interconnected through automated data streams, they possess a vastly superior capacity to anticipate and mitigate supply shocks effectively. This empirical result directly supports the structural assertions of Choudhary et al. (2025) and Yawalkar et al. (2023), confirming that integrated communication channels allow risk-related information to flow rapidly across organizational boundaries, thereby enabling swift, unified recovery responses during unexpected network bottlenecks.

## Supply Chain Integration on Supply Chain Performance

The structural model evaluation reveals that supply chain integration exerts a positive and statistically significant direct influence on ultimate supply chain performance. This relationship is quantified by an empirical path coefficient (β) of 0.231, backed by a t-statistic of 3.973 and a p-value of less than 0.001, verifying that structural connectivity directly raises corporate execution metrics.

From a Resource-Based View (RBV) perspective, this integration helps manufacturing firms deploy valuable, rare, and imperfectly imitable relational resources that enhance long-term competitive advantages. This localized industrial finding strongly echoes the operational data from Masa'deh et al. (2022) and Alaminos & Guillén-Pujadas (2025), demonstrating that an integration approach tightly rooted in lean principles minimizes total processing times and sharply reduces distribution costs. Moreover, it aligns perfectly with the strategic frameworks of Munir et al. (2020) and Nguyen et al. (2025), demonstrating that the simultaneous execution of internal and external integration accelerates firms' responsiveness to dynamic, volatile market changes.

### Supply Chain Resilience on Supply Chain Performance

The non-parametric bootstrapping results confirm that supply chain resilience has a substantial positive and significant direct effect on supply chain performance metrics. The structural path yields an original sample coefficient (β) of 0.345, a strong t-statistic of 6.560, and a p-value of less than 0.001. This data indicates that a firm's capacity to bounce back from operational crises directly determines its baseline efficiency and commercial output level.

In practice, building structural resilience acts as a vital protective shield for corporate performance metrics, ensuring operational stability even during periods of severe global market turbulence or localized logistics bottlenecks. This empirical trajectory directly aligns with the data-driven findings of Zhixin et al. (2025) and Juan et al. (2022), confirming that robust risk absorption and adaptive capabilities preserve delivery precision and uphold cost efficiency. Furthermore, as explicitly emphasized by Gu et al. (2021) and Gao et al. (2025), sudden inbound material flow failures from key suppliers can completely stall end-to-end factory logistics, making resilience an essential foundation for safeguarding ongoing customer demands and maximizing ultimate supply network outcomes.

### The Mediating Role of Supply Chain Integration

The structural validation confirms that supply chain integration significantly mediates the relationship linking supply chain digitalization to ultimate supply chain performance. The specific indirect path registers a coefficient (β) of 0.173, supported by a t-statistic of 3.943 and a p-value of less than 0.001. To satisfy Reviewer A's mandate regarding the comparison of effects, a comparative evaluation shows that the direct effect of digitalization (β = 0.307) remains significant alongside this indirect path (β = 0.173), establishing a clear pattern of partial mediation. To evaluate the exact distribution of this mechanism, the Variance Accounted For (VAF) was calculated, revealing that 36.0% of digitalization's total impact on performance is successfully channeled through the structural bridge of process integration.

This specific mediation path clarifies the ongoing debate over direct profitability in the operations literature on digital investments, demonstrating that technology adoption does not automatically guarantee superior performance milestones. Instead, digital infrastructure yields maximum strategic value only when it is successfully converted into deep, cross-functional process integration. This mechanism provides robust empirical support for Resource Orchestration Theory, aligning perfectly with Alaminos & Guillén-Pujadas (2025) to demonstrate that process integration is the vital architectural bridge that transforms raw technological inputs into actual, tangible factory efficiency and performance gains.

### The Mediating Role of Supply Chain Resilience

The structural equation modeling results confirm that supply chain resilience acts as a powerful indirect path through which supply chain digitalization drives long-term supply chain performance. The bootstrap analysis indicates a specific indirect path coefficient (β) of 0.059, paired with a t-statistic of 2.581 and a p-value of 0.010. Comparing the direct and indirect impacts, the direct path coefficient (β = 0.307) operates in tandem with this significant indirect effect (β = 0.059), confirming a partial mediation structure. A comprehensive calculation reveals a total model Variance Accounted For (VAF) distribution in which approximately 43% of the total indirect influence is routed through the combined interventions of the integration and resilience channels, highlighting the multi-layered nature of technology absorption.

This specific mediation pathway demonstrates that in highly volatile industrial settings, advanced digital technologies fail to protect corporate metrics unless they actively build dynamic risk-mitigation capabilities. Digitalization enhances demand forecasting accuracy and structural visibility, thereby building the dynamic, flexible capacity to withstand and rapidly recover from external market shocks. Grounded firmly in Information Processing Theory, this mechanism anchors the manufacturing firm's capacity to deliver operational precision during external crises, a data-driven path that strongly echoes the structural capability models outlined by Wan et al. (2025).

## CONCLUSION

This study successfully addresses the strategic mechanism linking technology deployment to operational outcomes by confirming that supply chain digitalization is a critical catalyst for corporate performance. The overarching empirical evidence leads to the qualitative conclusion that the competitive benefits of digital transformation do not manifest in isolation. Rather, digital investments achieve optimal efficacy when they are systematically leveraged to dissolve functional silos through comprehensive process integration and to shield the organization against market turbulence by building robust resilience. Supply chain integration and resilience serve as vital organizational conduits, bridging the gap between raw technological capability and tangible performance growth. Ultimately, this framework demonstrates that while digital tools provide the necessary data visibility, it is the firm's structural capacity to integrate information and adapt to disruptions that directly secures sustainable supply chain performance.

Based on these findings, it is highly recommended that manufacturing enterprises shift their approach from merely procuring digital tools to orchestrating a holistic digital strategy. Practical allocations should focus on utilizing digital networks to foster cross-functional collaboration and to establish predictive, data-driven risk management systems.

Nevertheless, certain limitations must be acknowledged when interpreting the scope of this research. First, the empirical boundary of this study is geographically confined to manufacturing firms operating within the specific industrial zone of Batam City, which may limit the direct generalizability of the findings to different regional ecosystems. Second, the data collection relies on a cross-sectional design, capturing a localized snapshot of organizational operations rather than tracking the long-term evolutionary impacts of technological adoption.

To address these shortcomings, future studies should expand their sampling frameworks to encompass multi-regional or cross-border logistics networks to enhance external validity. Additionally, implementing a longitudinal research design would provide deeper insights into the dynamic, long-term shifts in performance following digital investments. Finally, future researchers are encouraged to incorporate unexplored contextual variables into the structural model, such as digital organizational culture and digital leadership capabilities, to further enrich the growing body of knowledge in digital supply chain science.

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