



Print ISSN: 1738-3110 / Online ISSN 2093-7717
 JDS website: <http://accesson.kr/jds>
<http://doi.org/10.15722/jds.23.08.202508.47>

Driving Firm Performance through Digital Supply Chain Transformation: Evidence from Thailand's Manufacturing Sector

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Received: June 30, 2025. Revised: July 17, 2025. Accepted: August 05, 2025

Abstract

Purpose: As digital transformation reshapes global manufacturing, understanding how digital supply chain practices drive firm performance is critical. This study investigates the influence of supply chain digitalization, supply chain agility, innovation capability, digital transformation, and smart technologies on firm performance within Thailand's manufacturing sector. **Research design, data, and methodology:** A structured questionnaire was distributed to 415 mid-to-senior managers in supply chain, operations, innovation, and digital transformation roles using purposive, convenience, and snowball sampling techniques. Respondents were primarily from medium to large enterprises. Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA) were employed to test six hypothesized relationships among digitalization, agility, innovation, smart technologies, and firm performance. **Results:** Findings reveal that supply chain digitalization significantly impacts both supply chain agility ($\beta=0.217, p<0.05$) and innovation capability ($\beta=0.643, p<0.05$). Digital transformation positively affects smart technologies ($\beta=0.516, p<0.05$). In turn, agility ($\beta=0.137$), innovation capability ($\beta=0.454$), and smart technologies ($\beta=0.494$) significantly enhance firm performance. **Conclusions:** This study confirms the strategic role of digital transformation and innovation in boosting firm performance. The results offer practical insights for manufacturing leaders and policymakers aiming to leverage digital supply chain capabilities for sustained competitive advantage in Thailand's industrial landscape.

Keywords : Digital Transformation, Supply Chain Agility, Innovation Capability, Smart Technologies, Firm Performance

JEL Classification Code : M10, M31, L61, L62, O30

1. Introduction

In the era of rapid technological disruption, the integration of digital technologies into supply chain operations has become a strategic imperative for firms aiming to sustain competitiveness in dynamic markets. The concept of digital supply chain transformation—which encompasses the adoption of technologies such as IoT, AI, big data analytics, and cloud computing—has redefined how manufacturing firms operate, respond to market changes,

and deliver value to customers (Ivanov & Dolgui, 2020; Queiroz et al., 2020). Particularly in emerging economies like Thailand, where manufacturing plays a critical role in national GDP and exports, the pressure to digitally transform supply chains is intensifying amidst global shifts and disruptions such as the COVID-19 pandemic (OECD, 2021).

Thailand's manufacturing sector has long been a cornerstone of the country's economic development, contributing significantly to GDP, employment, and export

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revenues. It encompasses diverse industries including automotive, electronics, food processing, and textiles, which have progressively integrated into global value chains (Khao-uppatum & Chaisrisawatsuk, 2024). In recent years, Thailand has pursued the “Thailand 4.0” initiative to transform its industrial base through digital technologies and innovation, aiming to move from labor-intensive manufacturing to higher value-added production (Jones & Pimdee, 2017). Despite steady growth, the sector faces challenges such as rising labor costs, global competition, and supply chain disruptions, intensified by the COVID-19 pandemic (Yotwilai, 2021). Digital transformation and Industry 4.0 technologies have thus become critical for sustaining competitiveness and operational efficiency within the sector (Sahoo et al., 2023). However, many Thai manufacturing firms are still at varying stages of digital maturity, reflecting a need for empirical research on the adoption and impact of digital supply chain strategies within the local context (Areerakulkan & Sumrit, 2025).

Despite growing awareness, many firms struggle to realize measurable performance outcomes from digital initiatives. Studies show that digital transformation often fails to yield firm-level benefits when not strategically aligned with core capabilities like supply chain agility, innovation, and technology integration (Aker et al., 2016; Srai & Lorentz, 2019). While global research has examined digital transformation broadly, limited empirical evidence exists within the Thai manufacturing context regarding how digital supply chain practices contribute to firm performance through intermediary capabilities such as innovation capability, smart technologies, and agility (Ning & Yao, 2023; Wamba et al., 2017). Although studies like Wamba et al. (2017) and Ning and Yao (2023) focus on developed contexts, this research extends the literature by developing a structural model specific to Thailand's manufacturing sector. It builds on Sharma et al. (2025) by examining how smart technologies and innovation capability mediate the link between digitalization and firm performance in a Southeast Asian setting.

This gap in literature underscores the need for a more nuanced understanding of how digitalization influences supply chain processes and organizational outcomes in developing economies. Furthermore, the rapid advancement of Industry 4.0 technologies makes it essential to assess not only direct effects but also the mediating mechanisms that link digital transformation to firm success (Manzoor et al., 2025; Tavana et al., 2022). Few studies have systematically explored these interrelationships in Thailand's manufacturing sector, where digital maturity varies widely across firms and industries.

The significance of this study lies in providing empirical evidence on how supply chain digitalization and digital transformation drive firm performance through supply chain

agility, innovation capability, and smart technologies. By focusing on Thailand's manufacturing sector, this research contributes to both theory and practice, offering insights for policymakers, supply chain professionals, and business leaders navigating the path toward digital excellence. Therefore, this study focused on below objectives

1. To examine the impact of supply chain digitalization on supply chain agility and innovation capability.
2. To investigate the effect of digital transformation on the implementation of smart technologies.
3. To analyze how supply chain agility, innovation capability, and smart technologies contribute to firm performance.
4. To validate a structural model that explains the interrelationships among digital transformation, supply chain competencies, and performance outcomes in the Thai manufacturing context.

2. Literature Review

2.1. Supply Chain Digitalization

Supply chain digitalization refers to the integration and application of digital technologies—such as the Internet of Things (IoT), cloud computing, big data analytics, artificial intelligence (AI), and blockchain—across supply chain processes to enhance visibility, coordination, and decision-making (Kittipanya-Ngam & Tan, 2020). According to Wang and Prajogo (2024), supply chain digitalization (SCD) enhances a firm's ability to sense, respond to, and adapt to market changes, making it a key driver of supply chain agility (SCA). Digital tools such as IoT, cloud computing, and big data analytics improve real-time visibility and coordination across supply chain networks, allowing for faster and more informed decision-making (Ivanov & Dolgui, 2020; Son et al., 2021).

Wamba et al. (2017) found that big data analytics capability positively influences dynamic capabilities like responsiveness and adaptability—core dimensions of agility. Recent studies further support this relationship in the context of SMEs and developing economies (Tukamuhabwa et al., 2023). Nguyen et al. (2021) highlight that digital transformation empowers even resource-constrained firms to remain flexible during disruptions such as the COVID-19 pandemic. However, realizing the full benefits of digitalization requires supportive organizational capabilities, including strategic alignment and workforce readiness (Wang & Wang, 2024). Overall, the literature supports the hypothesis that supply chain digitalization significantly contributes to greater agility in supply chain operations.

Recent studies show that digitalization plays a critical role in enhancing innovation capability within supply chains

(Sharma et al., 2025; Zhao et al., 2023). By enabling seamless data sharing and collaboration among supply chain partners, digital technologies facilitate the co-creation of innovative solutions and accelerate the innovation process (Valencia et al., 2010). Moreover, the digital integration of supply chain activities reduces information silos and supports agile decision-making, which is essential for fostering innovation in fast-changing markets (Sharma et al., 2025). However, successful digitalization requires complementary organizational resources such as skilled personnel and strategic alignment to fully unlock innovation potential (Valmohammadi, 2017). The following hypotheses emerges from the literature analysis:

H1: *Supply chain digitalization has a significant impact on supply chain agility.*

H2: *Supply chain digitalization has a significant impact on innovation capability.*

2.2. Digital Transformation

Digital transformation refers to the integration of digital technologies into all areas of a business, fundamentally changing how organizations operate and deliver value (AlMulhim, 2021). It acts as a strategic enabler that fosters the adoption of smart technologies—such as Internet of Things (IoT), artificial intelligence (AI), blockchain, and robotics—that provide enhanced automation, connectivity, and real-time decision-making capabilities (Queiroz et al., 2020; Verhoef et al., 2021). Through digital transformation, firms shift from manual and siloed operations to interconnected, intelligent systems, improving efficiency and responsiveness (Kothapalli, 2022).

Empirical studies confirm that digital transformation significantly accelerates the deployment of smart technologies (AlMulhim, 2021). Ning and Yao (2023) found that digital transformation enhances integration of AI and IoT in supply chains, leading to improved agility and innovation. Sharma et al. (2025) also demonstrated that smart supply chains powered by digital transformation yield higher agility and resilience. However, successful adoption depends on organizational readiness, including skilled workforce and aligned strategies (Hradecky et al., 2022). Overall, the literature strongly supports the hypothesis below:

H3: *Digital transformation has a significant impact on smart technologies.*

2.3. Supply Chain Agility

Supply chain agility refers to a firm's ability to respond rapidly and effectively to changes in demand, supply disruptions, and market volatility through flexible and adaptive supply chain processes (Wang & Prajogo, 2024).

Agility is characterized by responsiveness, quick decision-making, and the ability to manage uncertainty—key capabilities in today's turbulent business environments. As Wang and Wang (2024) explain, supply chain agility is increasingly seen as a strategic asset that enables firms to sustain operations and customer satisfaction during disruptions like the COVID-19 pandemic.

Empirical evidence supports the idea that agility significantly enhances firm performance, including operational efficiency, customer responsiveness, and financial outcomes (Kurpjuweit et al., 2021). Studies such as Mishra et al. (2025) emphasize that agile supply chains facilitate faster delivery, reduced inventory costs, and better service levels, all of which contribute to improved competitiveness. Moreover, agile firms can seize market opportunities more effectively and recover from disruptions faster, leading to long-term strategic advantage. These findings affirm the hypothesis that supply chain agility plays a crucial role in driving superior firm performance across diverse industries (Tufan et al., 2024). Drawing upon the reviewed literature, the following hypothesis is proposed:

H4: *Supply chain agility has a significant impact on firm performance.*

2.4. Innovation Capability

Innovation capability is the ability of a firm to develop new products, processes, or business models, and to implement changes that improve competitiveness and performance (Anzules-Falcones & Novillo-Villegas, 2023). It is considered a dynamic capability that drives continuous improvement, adapts to technological and market changes, and creates customer value (Ellström et al., 2022). Firms with strong innovation capability tend to invest in R&D, encourage knowledge sharing, and foster a culture of creativity, all of which enhance their responsiveness to market demands (Wang & Prajogo, 2024).

Several studies have shown that innovation capability significantly influences firm performance, including financial growth, market share, and operational efficiency. For example, Wang and Wang (2024) demonstrated that innovation enhances firm sustainability and resilience, especially in post-pandemic markets. Additionally, Valencia et al. (2010) found that a supportive organizational culture promotes product innovation, which directly boosts firm outcomes. Empirical evidence confirms that firms leveraging innovation capability are better positioned to respond to disruption, achieve long-term strategic goals, and maintain competitive advantage (Olaleye et al., 2024). From the above discussion, the hypothesis is articulated as follows:

H5: *Innovation capability has a significant impact on firm performance.*

2.5. Smart Technologies

Smart technologies refer to advanced digital tools and systems embedded with capabilities such as automation, data analytics, artificial intelligence (AI), and the Internet of Things (IoT) that enable real-time monitoring, decision-making, and process optimization (Dinesh & Smith, 2024). These technologies allow firms to enhance operational efficiency, reduce costs, and improve product and service quality by facilitating seamless communication and integration across the supply chain (Kittipanya-Ngam & Tan, 2020). The adoption of smart technologies is a core component of digital transformation efforts, helping organizations become more responsive and innovative in dynamic markets (AlMulhim, 2021).

Empirical studies demonstrate that smart technologies significantly impact firm performance by boosting productivity, agility, and customer satisfaction. Sharma et al. (2025) found that firms implementing smart supply chains achieve greater resilience and sustainable performance. Similarly, Zhao et al. (2023) reported that smart technology adoption mediates the positive effects of digitalization on supply chain and overall firm performance. These findings confirm that smart technologies not only improve internal operations but also contribute to competitive advantage and long-term financial success, as hypothesized below:

H5: *Smart technologies have a significant influence on firm performance.*

2.6. Firm Performance

Firm performance is a multidimensional construct commonly assessed through financial outcomes (such as profitability, revenue growth, and return on assets), operational efficiency, market share, and customer satisfaction (Wang & Prajogo, 2024). It reflects an organization's ability to achieve its strategic goals and maintain competitive advantage in dynamic business environments. According to Handoyo et al. (2023), firm performance is largely influenced by a firm's resources and capabilities, emphasizing the role of strategic management in sustaining superior outcomes. Contemporary research expands this view by incorporating dynamic capabilities, innovation, and digital transformation as key drivers that enhance firm performance (Ellström et al., 2022; Wang & Wang, 2024).

Empirical studies have consistently demonstrated that investments in technology, innovation, and supply chain agility positively impact firm performance. For instance, Wamba et al. (2017) found that big data analytics capabilities enhance decision-making processes and financial results. Similarly, Wang and Wang (2024)

highlight supply chain agility as a critical antecedent to sustainable firm performance, especially in the post-COVID-19 context. Furthermore, digital transformation initiatives improve operational flexibility and customer responsiveness, leading to improved performance metrics across various industries (Sharma et al., 2025; Verhoef et al., 2021). These findings underscore the necessity for firms to continuously adapt and leverage new capabilities to sustain and improve performance in an increasingly competitive landscape (AlMulhim, 2021).

3. Research Methods and Materials

3.1. Research Framework and Hypotheses

This study integrates multiple theoretical perspectives to examine the relationships between digital technologies, innovation, and firm performance in supply chain contexts. The conceptual framework draws on AlMulhim (2021), Valmohammadi (2017), and Wang and Prajogo (2024), as outlined in Figure 1. Based on the conceptual framework, independent variables are those factors that influence or predict changes in other variables. Here, supply chain digitalization and digital transformation serve as independent variables affecting various outcomes. On the other hand, dependent variables are the outcomes or effects influenced by the independent variables. These include supply chain agility, innovation capability, smart technologies, and firm performance.

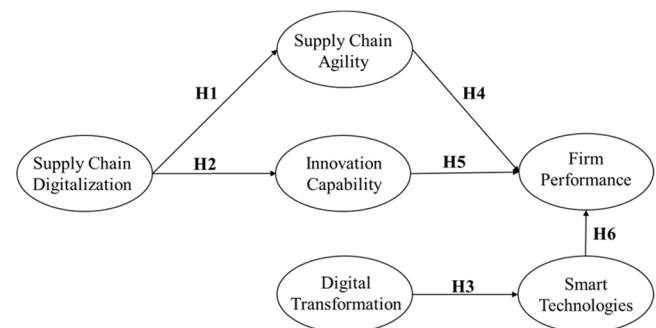


Figure 1: Conceptual Framework

- H1: Supply chain digitalization has a significant impact on supply chain agility.
- H2: Supply chain digitalization has a significant impact on innovation capability.
- H3: Digital transformation has a significant impact on smart technologies.
- H4: Supply chain agility has a significant impact on firm performance.
- H5: Innovation capability has a significant impact on firm

performance.

H6: Smart technologies have a significant influence on firm performance.

3.2. Methodology

This research employed a quantitative methodology with data collected through an online survey conducted between November 2024 and January 2025. The questionnaire was divided into three sections: initial screening questions (2 items), a set of 32 statements rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), and demographic questions (6 items). To ensure content validity, the survey items were evaluated through the item-objective congruence (IOC) method by three experts: two PhD holders and one Chief Executive Officer of a manufacturing company. All items received IOC scores exceeding the 0.6 threshold, confirming their relevance and clarity.

Before the full-scale data collection, a pilot study involving 40 respondents was performed to assess the reliability of the instrument. The reliability analysis yielded Cronbach's alpha values exceeding the 0.7 benchmark recommended by Nunnally and Bernstein (1994), indicating satisfactory internal consistency.

To validate the measurement model and test the proposed hypotheses, Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) techniques were applied. These statistical methods enabled an assessment of the model's fit and the examination of relationships among variables, including the effects of digitalization on agility and innovation, as well as the influence of smart technologies on overall firm performance. The analytical process was supported by rigorous reliability and validity checks to ensure the robustness of findings.

3.3. Population and Sample Size

The target population for this study comprises mid-to-senior level managers working in supply chain, operations, innovation, or digital transformation roles within Thailand's manufacturing sector. These individuals are strategically positioned to provide valuable insights due to their involvement in decision-making and implementation of digital supply chain practices. A commonly cited rule of thumb is at least 200 respondents to ensure stable and reliable results (Kline, 2015). To ensure a representative understanding of the sector, a sample size of 415 managers was selected using purposive, convenience, and snowball sampling techniques. This diverse sample primarily includes professionals from medium to large manufacturing enterprises, reflecting a broad spectrum of experience and expertise relevant to the study's focus on digital transformation and firm performance.

3.4. Sampling Technique

This study employed a mixed sampling approach to recruit mid-to-senior managers in supply chain, operations, innovation, and digital transformation roles within Thailand's manufacturing sector. Initially, purposive sampling was used to target participants with relevant expertise (Etikan et al., 2016). Convenience sampling facilitated data collection by reaching accessible respondents through professional networks, while snowball sampling helped expand the sample via referrals, enhancing diversity and representation (Naderifar et al., 2017). This combined strategy resulted in a sample of 415 managers from medium to large enterprises, providing robust data for analysis.

4. Results and Discussion

4.1. Demographic Profile

The sample consisted of 415 respondents with a fairly balanced gender distribution: 54% male and 46% female. Age-wise, the majority were between 25 and 44 years old (64.5%), with smaller shares under 25 (7.7%) and above 45 (27.7%). Most participants held at least a bachelor's degree (51.6%), followed by master's degree holders (28%) and a smaller proportion with vocational or lower education levels. Regarding job positions, middle managers or supervisors constituted the largest group (40.5%), followed by senior managers (33.5%) and executives/top management (9.9%). Experience varied, with about one-third (33%) having more than 10 years in their roles and the majority ranging from 1 to 10 years. Company sizes were mainly medium to large, with 52.5% working in firms with 200 or more employees and 31.6% in companies with 50–199 employees.

Table 1: Demographic Profile

Demographic Information		Frequency	%
Gender	Male	224	54.0
	Female	191	46.0
Age	Under 25	32	7.7
	25–34	118	28.4
	35–44	150	36.2
	45–54	81	19.5
	55 and above	34	8.2
Educational Level	High school diploma	20	4.8
	Vocational/Technical diploma	48	11.6
	Bachelor's degree	214	51.6
	Master's degree	116	28.0
	Doctoral degree	17	4.0
Current Job Position	Executive/Top Management	41	9.9
	Senior Manager	139	33.5
	Middle Manager/Supervisor	168	40.5
	Technical/Engineering Staff	52	12.5
	Other	15	3.6

Demographic Information		Frequency	%
Years of Experience	Less than 1 year	12	2.8
	1–3 years	65	15.7
	4–6 years	94	22.7
	7–10 years	107	25.8
	More than 10 years	137	33.0
Company Size/ Employees	Fewer than 50	66	15.9
	50–199	131	31.6
	200 or more	218	52.5

4.2. Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model and assess the reliability and validity of the constructs under investigation. CFA is a robust statistical method used to test whether the data fit a hypothesized measurement model based on prior theory (Brown, 2006). This approach allows for the confirmation of latent variables represented by observed indicators and ensures the construct validity necessary for subsequent hypothesis testing.

The reliability of each construct was evaluated using

Cronbach's Alpha, with all values exceeding the recommended threshold of 0.70 (Nunnally & Bernstein, 1994), indicating strong internal consistency (Table 2). Factor loadings for all items ranged between 0.592 and 0.885, surpassing the minimum criterion of 0.50 (Hair et al., 2010), confirming the individual item validity. Statistical significance was further supported by t-values greater than 1.98 and p-values below 0.05, ensuring the acceptability of the measurement model.

Composite Reliability (CR) values ranged from 0.805 to 0.888 across all constructs, exceeding the benchmark of 0.70, which confirms the constructs' reliability (Fornell & Larcker, 1981). Average Variance Extracted (AVE) values were mostly above the 0.50 criterion, except for Innovation Capability (0.452) and Smart Technologies (0.467), which were marginally lower but still acceptable given the strong CR values (Fornell & Larcker, 1981). These findings affirm adequate convergent validity.

Together, the reliability and validity results indicate that the measurement model is robust, supporting the use of these constructs for further structural analysis.

Table 2: Confirmatory Factor Analysis Result, Composite Reliability (CR) and Average Variance Extracted (AVE)

Variables	Source of Questionnaire	No. of Items	Cronbach's Alpha	Factors Loading	CR	AVE
Supply Chain Digitalization (SCD)	Wang and Prajogo (2024)	5	0.831	0.670-0.730	0.832	0.497
Supply Chain Agility (SCA)	Wang and Prajogo (2024)	6	0.885	0.646-0.826	0.886	0.566
Innovation Capability (INC)	Valmohammadi (2017)	8	0.866	0.609-0.718	0.868	0.452
Digital Transformation (DIT)	Yuan et al. (2024)	4	0.803	0.647-0.790	0.805	0.509
Smart Technologies (STE)	AlMulhim (2021)	6	0.838	0.592-0.732	0.839	0.467
Firm Performance (FP)	Wang and Prajogo (2024)	3	0.887	0.831-0.885	0.888	0.725

Note: CR = Composite Reliability, AVE = Average Variance Extracted

Discriminant validity was confirmed using the Fornell-Larcker criterion, where the square roots of the AVE values (diagonal) ranged from 0.673 to 0.852 and exceeded the correlations between constructs (off-diagonal values). This indicates that each construct shares more variance with its own indicators than with other constructs, demonstrating clear distinctiveness among variables such as smart technologies, supply chain digitalization, innovation capability, and firm performance (Fornell & Larcker, 1981). These results validate that the measurement model reliably differentiates between the key concepts in the study.

Table 3: Discriminant Validity

	STE	SCD	SCA	INC	DIT	FP
STE	0.683					
SCD	0.553	0.705				
SCA	0.287	0.200	0.752			
INC	0.575	0.630	0.224	0.673		
DIT	0.518	0.176	0.171	0.323	0.713	
FP	0.617	0.476	0.311	0.568	0.342	0.852

Note: The diagonally listed value is the AVE square roots of the variables

The measurement model demonstrated an acceptable fit according to multiple fit indices. The chi-square to degrees of freedom ratio (CMIN/DF) was 1.423, well below the recommended threshold of 3.0 (Hair et al., 2006). Other indices also met or exceeded the suggested criteria: GFI (0.914), AGFI (0.899), NFI (0.901), CFI (0.968), and TLI (0.965), all above the minimum acceptable value of 0.85 (Kline, 2015). Additionally, the RMSEA value was 0.032, indicating excellent fit as it is below the 0.08 cutoff (Hooper et al., 2008). Collectively, these results confirm that the measurement model fits the data well and is suitable for further structural analysis.

Table 4: Goodness of Fit of Measurement Model

Index	Acceptable Values	Measurement Model
CMIN/DF	< 3.00 (Hair et al., 2006)	639.057/449 = 1.423
GFI	≥ 0.85 (Kline, 2015)	0.914
AGFI	≥ 0.85 (Kline, 2015)	0.899
NFI	≥ 0.85 (Kline, 2015)	0.901
CFI	≥ 0.85 (Kline, 2015)	0.968
TLI	≥ 0.85 (Kline, 2015)	0.965
RMSEA	≤ 0.08 (Hooper et al., 2008)	0.032
Model summary		Acceptable Model Fit

Remark: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, and RMSEA = root mean square error of approximation

4.3. Structural Equation Model (SEM)

The structural model demonstrated a satisfactory fit with the data, as indicated by various fit indices. The chi-square to degrees of freedom ratio (CMIN/DF) was 1.867, which is well below the recommended maximum of 3.0 (Hair et al., 2006). Other indices also met the acceptable thresholds: GFI (0.893), AGFI (0.877), NFI (0.867), CFI (0.933), and TLI (0.928), all exceeding the minimum acceptable value of 0.85 (Kline, 2015). The RMSEA value was 0.046, indicating a good fit since it is below the 0.08 cutoff (Hooper et al., 2008). Overall, these results confirm that the structural model fits the data well and is appropriate for hypothesis testing.

Table 5: Goodness of Fit of Structural Model

Index	Acceptable Values	Measurement Model
CMIN/DF	< 3.00 (Hair et al., 2006)	855.293/458 = 1.867
GFI	≥ 0.85 (Kline, 2015)	0.893
AGFI	≥ 0.85 (Kline, 2015)	0.877
NFI	≥ 0.85 (Kline, 2015)	0.867
CFI	≥ 0.85 (Kline, 2015)	0.933
TLI	≥ 0.85 (Kline, 2015)	0.928
RMSEA	≤ 0.08 (Hooper et al., 2008)	0.046
Model summary		Acceptable Model Fit

Remark: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, and RMSEA = root mean square error of approximation

4.4. Research Hypothesis Testing Result

The results of hypothesis testing are summarized in Table 6, where the significance level was set at $p < 0.05$. All six hypotheses were supported based on the standardized path coefficients (β), standard errors (S.E.), and t-values.

Table 6: Hypothesis Result of the Structural Model

H	Paths	(β)	S.E.	t-Value	Tests Result
H1	SCA <--- SCD	0.217	0.058	3.763*	Supported
H2	INC <--- SCD	0.643	0.066	9.615*	Supported
H3	STE <--- DIT	0.516	0.061	7.398*	Supported
H4	FP <--- SCA	0.137	0.049	2.996*	Supported
H5	FP <--- INC	0.454	0.058	8.430*	Supported
H6	FP <--- STE	0.494	0.078	8.138*	Supported

Note: * $p < 0.05$

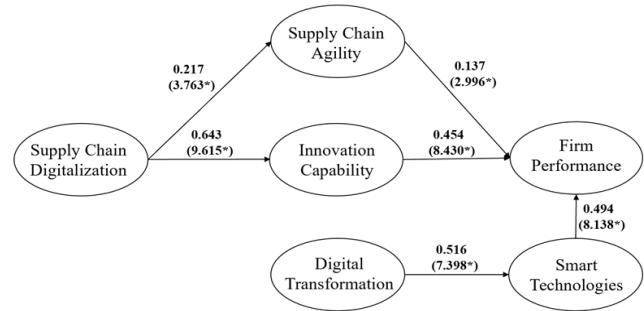


Figure 2: The Results of Structural Model

Remark: Dashed lines, not significant; solid lines, significant. * $p < 0.05$

H1: Supply chain digitalization (SCD) was found to have a significant positive effect on supply chain agility (SCA), with a standardized path coefficient (β) of 0.217, standard error (S.E.) of 0.058, and a t-value of 3.763. This confirms that organizations leveraging digital supply chain technologies enhance their agility, allowing faster and more flexible responses to market demands. This finding aligns with prior research by Wang and Prajogo (2024), who demonstrated that digital tools improve supply chain responsiveness and adaptability.

H2: The impact of supply chain digitalization on innovation capability (INC) was strongly supported ($\beta = 0.643$, S.E. = 0.066, $t = 9.615$), indicating that digitalization not only facilitates operational efficiency but also fosters a firm's capacity to innovate in processes, products, and services. This outcome corroborates the work of Valmohammadi (2017), who linked digital initiatives with enhanced innovation capabilities in supply chains.

H3: Digital transformation (DIT) significantly influenced smart technologies (STE) adoption ($\beta = 0.516$, S.E. = 0.061, $t = 7.398$), underscoring that strategic digital transformation efforts drive the integration of advanced technologies such as IoT, AI, and big data analytics. This result supports AlMulhim's (2021) findings on the critical role of digital transformation in enabling smart technology deployment in supply chain management.

H4: Supply chain agility positively affected firm performance (FP) ($\beta = 0.137$, S.E. = 0.049, $t = 2.996$), suggesting that agile supply chains contribute to better overall firm outcomes. This is consistent with Wang and Wang (2024), who emphasized agility as a key driver of sustainability and performance in the post-COVID-19 business environment.

H5: Innovation capability exhibited a strong positive impact on firm performance ($\beta = 0.454$, S.E. = 0.058, $t = 8.430$), confirming that firms with higher innovation capacity tend to achieve superior performance metrics. This

supports the extensive literature highlighting innovation as a fundamental competitive advantage (Ellström et al., 2022).

H6: Finally, smart technologies significantly influenced firm performance ($\beta = 0.494$, S.E. = 0.078, $t = 8.138$), indicating that adopting intelligent systems and technologies directly contributes to enhanced operational efficiency and business success. This aligns with findings from Dinesh and Smith (2024), who documented improved operational outcomes through IoT and AI integration.

5. Conclusions and Recommendation

5.1. Conclusion and Discussion

This study aimed to explore the dynamic relationships among supply chain digitalization, digital transformation, supply chain agility, innovation capability, smart technologies, and firm performance within Thailand's manufacturing sector. The findings provide empirical evidence supporting all hypothesized relationships and offer insightful implications for both theory and practice.

Firstly, the results confirm that supply chain digitalization significantly enhances both supply chain agility and innovation capability, fulfilling the first research objective. This supports the view that integrating digital tools and technologies into supply chain processes improves responsiveness and flexibility (Wang & Prajogo, 2024), while simultaneously fostering a culture and capability for innovation (Valmohammadi, 2017). This dual impact highlights digitalization as a critical enabler for firms seeking competitive advantage in fast-evolving markets.

Secondly, digital transformation was shown to have a significant effect on the adoption and implementation of smart technologies, addressing the second research objective. This outcome aligns with AlMulhim (2021), who emphasized that strategic digital transformation initiatives provide the necessary foundation for deploying advanced technologies such as IoT, AI, and big data analytics. It underscores the importance of holistic transformation efforts beyond mere technology adoption to achieve smart supply chain functionality.

Thirdly, supply chain agility, innovation capability, and smart technologies each demonstrated significant positive contributions to firm performance, satisfying the third research objective. These findings echo prior research by Wang and Wang (2024) and Ellström et al. (2022), reinforcing that agility allows firms to swiftly adapt to market changes, innovation capability drives sustainable competitive advantage, and smart technologies enhance operational efficiency and decision-making. Together, these competencies create a synergistic effect that elevates overall firm performance. While the relationship between supply

chain agility and firm performance is statistically significant ($\beta = 0.137$), the effect size is relatively modest. This suggests that although agility contributes to firm performance, its impact may be less pronounced compared to other factors such as innovation capability or smart technologies.

Finally, the study successfully validated a comprehensive structural model elucidating the interrelationships among digital transformation, supply chain competencies, and performance outcomes, fulfilling the fourth research objective. The model's robust fit and supported paths confirm that digital transformation initiatives indirectly impact firm performance through supply chain digitalization, agility, innovation, and smart technologies. This integrated perspective contributes to the growing body of knowledge on digital supply chain management in emerging economies like Thailand, offering actionable insights for practitioners and policymakers.

This study advances theory by developing and empirically validating a structural model that explains how digital supply chain transformation influences firm performance within Thailand's manufacturing sector. By incorporating the mediating roles of smart technologies and innovation capability, it extends existing research and provides a deeper understanding of digitalization impacts in a developing economy context. From a practical standpoint, the findings offer valuable insights for managers and policymakers seeking to enhance supply chain agility, promote innovation, and effectively implement smart technologies. The study identifies strategic areas for investment and organizational change that can drive performance improvements and strengthen competitiveness in Thailand's manufacturing industry.

The findings of this study should be interpreted in light of Thailand's unique cultural and institutional context. Thai business culture, which emphasizes hierarchical structures, strong interpersonal relationships, and collective decision-making, may influence how digital transformation initiatives are adopted and implemented within manufacturing firms. Additionally, local factors such as regulatory environment, government policies like "Thailand 4.0," and varying levels of technological readiness across industries shape the pace and effectiveness of supply chain digitalization. These cultural and contextual nuances suggest that strategies effective in Western or developed markets may require adaptation to align with Thai organizational norms and practices. Future research could further explore how cultural dimensions impact digital transformation processes and outcomes in Southeast Asia.

In conclusion, this research advances understanding of how digitalization and transformation drive supply chain capabilities that, in turn, enhance firm performance. It highlights the strategic necessity for Thai manufacturers to

invest in digital tools, foster innovation, and adopt smart technologies as part of a coordinated effort to thrive in the increasingly digital and competitive global market.

5.2. Recommendation

Based on the findings of this study, several key recommendations are proposed to support manufacturing firms in Thailand as they seek to leverage digital supply chain capabilities for enhanced performance and competitiveness. First, it is imperative that organizations invest strategically in supply chain digitalization technologies. Tools such as cloud computing, RFID, and real-time data analytics have demonstrated their effectiveness in improving supply chain agility and innovation capability. By integrating these technologies, firms can build a strong foundation for greater responsiveness and innovation, which are crucial in today's rapidly changing business environment (Valmohammadi, 2017; Wang & Prajogo, 2024).

Beyond the implementation of individual technologies, firms should adopt a holistic approach to digital transformation. This means developing comprehensive strategies that not only focus on technology adoption but also address organizational culture, process redesign, and workforce capability building. Such an integrated transformation approach facilitates the successful deployment of smart technologies, including artificial intelligence and the Internet of Things, which play a vital role in optimizing supply chain operations and enhancing firm performance (AlMulhim, 2021). Companies that focus solely on technology without aligning their internal processes and culture may struggle to realize the full benefits of digital transformation.

Additionally, enhancing supply chain agility through the redesign of flexible and adaptive processes is critical. Firms need to develop the capability to quickly respond to market fluctuations and disruptions, thereby safeguarding operational continuity and competitive advantage. This agility directly contributes to improved firm performance and resilience, especially in an era marked by volatility and uncertainty (Handoyo et al., 2023). Concurrently, fostering innovation capability must remain a continuous priority. Creating an organizational culture that encourages experimentation, knowledge sharing, and continuous improvement will empower firms to sustain product and process innovation, which is a key driver of long-term success (Ellström et al., 2022).

Furthermore, firms should actively pursue the adoption of smart technologies such as IoT sensors, big data analytics, and AI-powered decision-making systems. These technologies provide real-time insights and operational efficiencies that significantly boost firm performance and

competitiveness (Dinesh & Smith, 2024). Finally, recognizing that digital transformation can pose challenges—particularly for small and medium enterprises—government agencies and industry bodies should develop supportive policies. These could include financial incentives, specialized training programs, and consultancy services to help firms overcome barriers to technology adoption and build digital capabilities.

In summary, a coordinated effort involving strategic investment, cultural transformation, process flexibility, continuous innovation, and smart technology adoption, supported by enabling policies, will position Thailand's manufacturing sector to capitalize on the benefits of digital supply chain transformation and achieve sustained competitive advantage.

5.3. Limitation and Further Study

Despite the valuable insights gained from this research, several limitations should be acknowledged. First, the study's data were collected exclusively from mid-to-senior managers within Thailand's manufacturing sector, which may limit the generalizability of the findings to other industries or geographic regions. Future research could expand the scope to include diverse sectors and cross-country comparisons to validate the model in different contexts.

Second, the cross-sectional research design restricts the ability to infer causal relationships among the constructs. Longitudinal studies would be beneficial to observe how supply chain digitalization, digital transformation, and smart technologies impact firm performance over time and through different stages of technology adoption.

Third, the reliance on self-reported data introduces the potential for response bias, including social desirability and common method variance. Future studies might employ mixed-method approaches, such as combining surveys with qualitative interviews or secondary performance data, to enhance the robustness and depth of findings.

Forth, while AVE is a widely used measure of convergent validity in CFA, it has some limitations. Specifically, AVE can be a conservative estimate and may underestimate the true variance captured by a construct, especially when factor loadings are moderate (Fornell & Larcker, 1981). Additionally, AVE does not account for measurement errors correlated across items, which can affect its accuracy. Therefore, AVE results should be interpreted alongside other validity measures such as composite reliability and factor loadings to obtain a comprehensive assessment of construct validity.

Additionally, the use of non-probability sampling methods—namely purposive, convenience, and snowball sampling—may introduce selection bias and limit the

representativeness of the sample. Future research could expand the scope to include diverse sectors and cross-country comparisons to validate the model in different contexts.

Finally, this study did not include control variables such as firm size, industry sub-sector, or market conditions, which may influence the relationships examined. Future research could incorporate relevant control variables to better isolate the effects of digital transformation and supply chain capabilities on firm performance. Including such controls would strengthen the robustness and generalizability of the findings.

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