The Effect of Digital Supply Chain Integration on Sustainable Logistics Performance: Empirical Evidence from Logistics and Transportation Firms in Thailand

Rattawut Chaola*, Penpak Rattana-ngam*[1]

Abstract

This study examines the effect of digital supply chain integration on sustainable logistics performance in the logistics and transportation sector, with a focus on supply chain resilience, supply chain agility, and the moderating role of government policy support. Although prior studies have explored digital transformation in supply chains, limited attention has been given to how digital supply chain integration improves sustainable logistics performance through adaptive capabilities in emerging economies. Drawing on dynamic capability theory and contingency theory, digital supply chain integration is conceptualized as a strategic capability that enables firms to respond effectively to uncertainty. Data were collected from 112 logistics firms in Thailand and analyzed using OLS regression and bootstrapping procedures. The results indicate that digital supply chain integration positively affects supply chain resilience (β = 0.857, p < .001), supply chain agility (β = 0.741, p < .001), and sustainable logistics performance (β = 0.331, p < .01). In addition, resilience (β = 0.275, p < .001) and agility (β = 0.282, p < .001) positively influence sustainable logistics performance. The findings also suggest that resilience and agility jointly support how digital supply chain integration enhances sustainable logistics performance. Although government policy support has no direct effect, it strengthens the relationship between digital integration and sustainable logistics performance (β = 0.094, p < .05). This study extends dynamic capability theory and provides practical implications for enhancing supply chain sustainability.

Keywords: Digital supply chain integration, Supply chain resilience, Supply chain agility, Government policy support, Sustainable logistics performance

* Instructor, Faculty of Management Sciences and Information Technology, Nakhon Phanom University

*[1] Corresponding author, email: Penpuk@npu.ac.th, Tel. 096-326-9229

Received : January 30, 2026; **Revised** : May 5, 2026; **Accepted** : June 8, 2026

ผลกระทบของการบูรณาการซัพพลายเชนดิจิทัลต่อผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืน: หลักฐานเชิงประจักษ์จากธุรกิจโลจิสติกส์และการขนส่งในประเทศไทย

รัฐวุฒิ เจาลา*, เพ็ญพักตร์ รัตนงาม*[1]

บทคัดย่อ

การวิจัยครั้งนี้ศึกษาผลของการบูรณาการซัพพลายเชนดิจิทัลที่มีต่อผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืนในธุรกิจโลจิสติกส์และการขนส่ง โดยมุ่งเน้นบทบาทของความสามารถในการฟื้นตัวของซัพพลายเชน ความคล่องตัวของซัพพลายเชน และการสนับสนุนจากภาครัฐ แม้ว่างานวิจัยที่ผ่านมาได้ศึกษาการเปลี่ยนผ่านสู่ดิจิทัลในซัพพลายเชน แต่ยังมีข้อจำกัดในการอธิบายว่าการบูรณาการซัพพลายเชนดิจิทัลช่วยยกระดับผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืนผ่านความสามารถเชิงปรับตัวในบริบทของประเทศเศรษฐกิจเกิดใหม่ได้อย่างไร โดยอาศัยกรอบแนวคิดทฤษฎีความสามารถเชิงพลวัตและทฤษฎีการปรับตามสถานการณ์ ข้อมูลถูกเก็บรวบรวมจากธุรกิจโลจิสติกส์ในประเทศไทยจำนวน 112 แห่ง และวิเคราะห์ด้วยการวิเคราะห์การถดถอยแบบกำลังสองน้อยที่สุดร่วมกับวิธีบูตสแตรป ผลการศึกษาพบว่า การบูรณาการซัพพลายเชนดิจิทัลมีอิทธิพลเชิงบวกต่อความสามารถในการฟื้นตัวของซัพพลายเชน (β = 0.857, $p < .001$) ความคล่องตัวของซัพพลายเชน (β = 0.741, $p < .001$) และผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืน (β = 0.331, $p < .01$) นอกจากนี้ ความสามารถในการฟื้นตัวของซัพพลายเชน (β = 0.275, $p < .001$) และความคล่องตัวของซัพพลายเชน (β = 0.282, $p < .001$) ยังส่งผลเชิงบวกต่อผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืนอีกด้วย ผลการศึกษายังสะท้อนให้เห็นว่า ความสามารถในการฟื้นตัวและความคล่องตัวของซัพพลายเชนมีบทบาทร่วมกันในการอธิบายความสัมพันธ์ระหว่างการบูรณาการซัพพลายเชนดิจิทัลกับผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืน แม้ว่าการสนับสนุนจากภาครัฐจะไม่มีอิทธิพลโดยตรงต่อผลการดำเนินงาน แต่กลับช่วยเสริมความสัมพันธ์ระหว่างการบูรณาการดิจิทัลกับผลการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืน (β = 0.094, $p < .05$) ผลการศึกษาครั้งนี้ช่วยขยายองค์ความรู้ของทฤษฎีความสามารถเชิงพลวัต และนำเสนอข้อเสนอแนะเชิงปฏิบัติสำหรับการยกระดับความยั่งยืนของซัพพลายเชนในภาคธุรกิจโลจิสติกส์และการขนส่ง

คำสำคัญ: การบูรณาการซัพพลายเชนดิจิทัล, ความยืดหยุ่นของซัพพลายเชน, ความคล่องตัวของซัพพลายเชน, การสนับสนุนนโยบายภาครัฐ, ผลการการดำเนินงานด้านโลจิสติกส์อย่างยั่งยืน

* อาจารย์ คณะวิทยาการจัดการและเทคโนโลยีสารสนเทศ มหาวิทยาลัยนครพนม

*[1] Corresponding author, email: Penpuk@npu.ac.th, Tel. 096-326-9229

Received : January 30, 2026; **Revised** : May 5, 2026; **Accepted** : June 8, 2026

Introduction

In recent years, the logistics and transportation industry have undergone substantial transformation driven by rapid advances in digital technologies, growing environmental concerns, and evolving customer expectations. Globally, supply chains have increasingly adopted digitalization as a strategic response to demands for real-time responsiveness, operational efficiency, and sustainability (Ivanov et al., 2019; Yu et al., 2018). Technologies such as big data analytics, cloud-based platforms, and real-time tracking systems have reshaped how logistics activities are coordinated and optimized across supply chain networks.

In Thailand, the logistics and transportation sector play a vital role in national economic development by supporting cross-border trade, facilitating the expansion of e-commerce, and strengthening regional connectivity within the ASEAN Economic Community (National Economic and Social Development Council, 2023). Despite its strategic importance, many Thai logistics firms continue to face persistent challenges, including fragmented information systems, limited interoperability among supply chain partners, and increasing exposure to disruptions. These structural and technological constraints not only hinder operational efficiency but also limit firms' ability to achieve sustainability-oriented performance, particularly in a rapidly evolving digital environment.

At the center of this transformation is digital supply chain integration, defined as a firm's ability to deploy and interconnect digital technologies across supply chain processes to enable real-time information sharing, operational visibility, and collaborative decision-making (Teixeira et al., 2025; Ogunwole et al., 2024). Unlike traditional information technology adoption, digital supply chain integration emphasizes system-wide integration that bridges internal functions and external partners, thereby enhancing coordination and responsiveness under uncertainty. From the perspective of dynamic capability theory, digital supply chain integration represents a higher-order organizational capability that enables firms to sense environmental changes, seize technological opportunities, and reconfigure resources to maintain competitiveness in dynamic environments (Teece et al., 1997; Al-Khatib & Ramayah, 2024). This perspective suggests that digital integration is not merely a technological upgrade, but a strategic capability that shapes how firms develop adaptive supply chain processes and achieve sustainable performance outcomes.

Building on this foundation, the present study focuses on two key supply chain capabilities closely associated with digital integration, namely supply chain resilience and supply chain agility. Supply chain resilience refers to a firm's ability to anticipate, absorb, adapt to, and recover from disruptions while maintaining operational continuity (Qi et al.,

2022), whereas supply chain agility reflects the ability to rapidly adjust logistics processes and resource configurations in response to market changes (Zhou et al., 2023). Rather than operating independently, these capabilities function as critical mechanisms through which digital supply chain integration can be translated into improved performance, particularly under conditions of environmental uncertainty.

In addition to internal capabilities, external institutional conditions also shape the effectiveness of digital transformation. Government policy support represents an important contextual factor influencing the outcomes of digital supply chain integration initiatives. Such support may include regulatory frameworks, digital infrastructure investment, and innovation-oriented policies that facilitate technology adoption in the logistics sector (Zhao & Liu, 2024; Baah et al., 2024). Consistent with contingency theory, organizational performance depends on the alignment between internal capabilities and external environmental conditions (Peng & Sun, 2024). Thus, the effectiveness of digital supply chain integration is likely to vary depending on the extent to which supportive institutional conditions are present.

Despite the growing body of literature on digital transformation and supply chain performance, prior studies have primarily examined these relationships in isolation, focusing either on technological adoption or on individual supply chain capabilities, without fully explaining how digital integration is translated into sustainability outcomes through adaptive mechanisms. In addition, empirical evidence from emerging economies, particularly Thailand, remains limited and fragmented. This gap is critical, as institutional conditions and technological readiness in emerging markets differ significantly from those in developed economies, potentially shaping the effectiveness of digital supply chain initiatives.

To address these limitations, this study develops and empirically tests an integrated framework linking digital supply chain integration with supply chain resilience, supply chain agility, and sustainable logistics performance, while also examining the moderating role of government policy support. By integrating insights from dynamic capability theory and contingency theory, this study extends the literature on digital supply chain management by explaining how adaptive supply chain capabilities contribute to sustainability outcomes under conditions of uncertainty. In addition, this study provides empirical evidence from the Thai logistics and transportation sector, where digital transformation and institutional support continue to evolve.

Objectives

1. To examine the effect of digital supply chain integration on supply chain resilience, supply chain agility, and sustainable logistics performance.

2. To examine the effects of supply chain resilience and supply chain agility on sustainable logistics performance.

3. To examine the mediating effects of supply chain resilience and supply chain agility on the relationship between digital supply chain integration and sustainable logistics performance.

4. To examine the moderating effects of government policy support in the relationship between digital supply chain integration and sustainable logistics performance.

Literature Review

Conceptual Framework

This study proposes a conceptual framework grounded in dynamic capability theory and contingency theory to explain how digital transformation shapes sustainable logistics performance. From a dynamic capability perspective, digital supply chain integration represents a higher-order organizational capability that enables firms to sense environmental changes, coordinate logistics activities, and reconfigure resources through the effective use of digital technologies (Teece et al., 1997; Al-Khatib & Ramayah, 2024). Such integration enhances information visibility and coordination, thereby strengthening supply chain resilience and supply chain agility, which are essential for managing disruptions and responding to market volatility. Drawing on contingency theory, the framework further recognizes government policy support as an external condition that can influence the effectiveness of digital integration in achieving sustainable logistics outcomes (Peng & Sun, 2024). The proposed relationships are summarized in Figure 1.

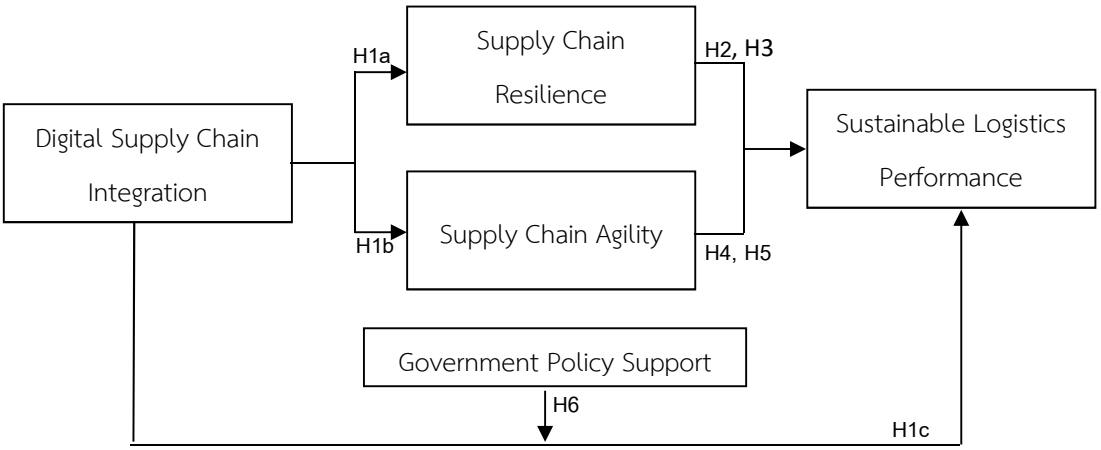

Figure 1 Conceptual Framework of the Study

Digital Supply Chain Integration (DSCI)

Digital supply chain integration refers to a firm's ability to deploy and interconnect digital technologies across supply chain processes to enable real-time information sharing, operational visibility, and coordinated decision-making among internal and external supply chain partners (Teixeira et al., 2025; Ogunwole et al., 2024). Unlike traditional information technology adoption, DSCI emphasizes system-wide integration that supports end-to-end coordination across organizational boundaries. From the perspective of dynamic capability theory, digital supply chain integration represents a higher-order organizational capability that enables firms to sense environmental changes, seize technological opportunities, and reconfigure resources under uncertain conditions (Teece et al., 1997; Al-Khatib & Ramayah, 2024).

While prior studies consistently highlight the role of digital technologies in improving supply chain performance, existing research has primarily focused on isolated technological applications or direct operational outcomes, with limited attention to how integrated digital capabilities support adaptive supply chain responses and sustainability outcomes. Moreover, some studies suggest that digital technologies alone may not necessarily improve sustainable performance without complementary organizational capabilities and adaptive processes (Ciampi et al., 2021; Le & Fan, 2023).

Building on this perspective, digitally integrated supply chains enhance real-time information visibility and collaboration among supply chain partners, enabling firms to anticipate disruptions, maintain operational continuity, and strengthen supply chain resilience (Ivanov et al., 2019; Bag et al., 2022). In addition, improved digital connectivity facilitates faster information flows and operational responsiveness, thereby enhancing supply chain agility in dynamic and uncertain environments (Kache & Seuring, 2017; Yu et al., 2018). In this regard, resilience and agility represent important adaptive capabilities through which firms can translate digital integration into more responsive and flexible logistics operations.

Beyond adaptive capabilities, digital supply chain integration is also expected to directly improve sustainable logistics performance by enhancing process efficiency, reducing operational waste, and optimizing resource utilization across logistics activities (Bag et al., 2022; Mohaghegh et al., 2025). Taken together, these arguments suggest that digital supply chain integration enhances sustainable logistics performance both directly and through the development of adaptive supply chain capabilities. Therefore,

Hypothesis 1: Digital supply chain integration has a positive effect on a) supply chain resilience, b) supply chain agility, and c) sustainable logistics performance.

Supply Chain Resilience (SCR)

Supply chain resilience refers to a firm's ability to anticipate, absorb, adapt to, and recover from disruptions while maintaining continuity of supply chain operations (Qi et al., 2022). In the logistics and transportation context, resilience reflects a firm's capacity to cope with unexpected events such as operational disruptions, demand fluctuations, and external crises without substantial deterioration in performance (Scholten et al., 2020). A resilient supply chain enables firms to adjust logistics processes and reallocate resources under uncertain conditions, thereby supporting operational stability over time. While prior studies widely recognize the importance of supply chain resilience in managing disruptions, existing research has primarily emphasized short-term recovery and operational continuity, with relatively limited attention given to its broader role in supporting sustainable logistics performance. In addition, some studies suggest that resilience alone may not be sufficient to ensure long-term sustainability unless firms possess complementary digital and adaptive capabilities (Scholten et al., 2020; Ivanov et al., 2019).

Firms with strong resilience capabilities are generally better able to maintain service continuity, reduce the severity of disruptions, and shorten recovery periods, which contributes directly to improved logistics performance (Ivanov et al., 2019). This capability enables firms to sustain operational reliability and avoid severe performance declines during periods of uncertainty. Moreover, resilience supports sustainability objectives by reducing inefficient recovery activities, limiting unnecessary resource consumption, and minimizing environmental impacts during operational disruptions (Kache & Seuring, 2017). In this regard, supply chain resilience represents an important adaptive capability that enables firms to translate digital integration into more stable and sustainable logistics operations under uncertain conditions (Ivanov et al., 2019; Qi et al., 2022). By maintaining stable operations and minimizing inefficient recovery actions, resilient supply chains help ensure more consistent resource utilization and reduce negative environmental consequences (Kache & Seuring, 2017; Ivanov et al., 2019). Taken together, these arguments suggest that supply chain resilience positively contributes to sustainable logistics performance. Therefore,

Hypothesis 2: Supply chain resilience has a positive effect on sustainable logistics performance.

Hypothesis 3: Supply chain resilience mediates the relationship between digital supply chain integration and sustainable logistics performance.

Supply Chain Agility (SCA)

Supply chain agility refers to a firm's ability to quickly sense changes in market conditions and adjust supply chain processes, resource allocations, and service delivery in response to demand fluctuations and environmental uncertainty (Zhou et al., 2023). In logistics and transportation operations, agility reflects a firm's capacity to respond flexibly to changing customer requirements, technological developments, and unexpected operational challenges. Agile logistics systems support timely decision-making and process reconfiguration, enabling firms to reduce delays and maintain service reliability under dynamic conditions. While prior research has consistently linked supply chain agility to improved operational outcomes, existing studies have primarily emphasized short-term responsiveness and operational flexibility, with relatively limited attention given to its broader role in supporting sustainable logistics performance (Kache & Seuring, 2017). In addition, some studies suggest that agility alone may not necessarily improve long-term sustainability unless firms possess complementary digital integration and adaptive organizational capabilities (Mohaghegh et al., 2025; Le & Fan, 2023).

Higher levels of supply chain agility are associated with improved operational efficiency and customer satisfaction, both of which are essential for sustainable logistics performance (Kache & Seuring, 2017; Yu et al., 2018). In addition, agility contributes to sustainability by promoting more efficient resource utilization and reducing unnecessary transportation activities and environmental impacts (Mohaghegh et al., 2025). By enabling rapid adjustments in logistics processes and more efficient allocation of resources, supply chain agility helps firms maintain service continuity while minimizing operational inefficiencies under conditions of uncertainty. In this regard, supply chain agility represents an important adaptive capability through which firms can translate digital integration into more responsive and sustainable logistics operations (Yu et al., 2018; Mohaghegh et al., 2025). Taken together, these arguments suggest that supply chain agility enhances sustainable logistics performance by improving responsiveness, supporting efficient operations, and reducing resource waste in dynamic environments. Accordingly, supply chain agility is expected to positively influence sustainable logistics performance. Therefore,

Hypothesis 4: Supply chain agility has a positive effect on sustainable logistics performance.

Hypothesis 5: Supply chain agility mediates the relationship between digital supply chain integration and sustainable logistics performance.

Government Policy Support (GPS)

Government policy support refers to the extent to which governmental regulations, initiatives, and public investments facilitate the adoption and effective use of digital technologies in the logistics and transportation sector (Zhao & Liu, 2024; Baah et al., 2024). Such support includes digital infrastructure development, regulatory clarity, financial incentives, and innovation-oriented policies that encourage firms to implement digital solutions across supply chain operations (Haqqi, 2023). In emerging economies, policy support plays an important role in reducing institutional constraints and enhancing firms' readiness for digital transformation. While prior studies emphasize the importance of supportive policy environments in promoting technology adoption, existing research has primarily focused on the direct effects of government support on firm performance, with relatively limited attention given to how policy conditions influence the effectiveness of firm-level digital capabilities (Peng & Sun, 2024). Moreover, some studies suggest that policy support alone may not necessarily improve organizational performance unless firms possess sufficient technological and adaptive capabilities to effectively utilize such support (Baah et al., 2024; Zhao & Liu, 2024).

Supportive policy environments enhance infrastructure readiness, reduce regulatory uncertainty, and facilitate access to technological resources, thereby improving the conditions under which digital supply chain integration can be effectively implemented (Haqqi, 2023). In this context, government policy support does not independently generate sustainable logistics performance, but rather strengthens the effectiveness of digital integration efforts by creating a more conducive institutional environment. Accordingly, government policy support represents an important contextual condition that enables firms to more effectively leverage digital supply chain capabilities under dynamic and uncertain environments (Peng & Sun, 2024). Taken together, these arguments suggest that government policy support positively moderates the relationship between digital supply chain integration and sustainable logistics performance. Therefore,

Hypothesis 6: Government policy support positively moderates the relationship between digital supply chain integration and sustainable logistics performance.

Sustainable Logistics Performance (SLP)

Sustainable logistics performance refers to the extent to which logistics and transportation operations achieve long-term economic efficiency while minimizing environmental impacts and supporting responsible resource utilization. In this study, sustainable logistics performance reflects a firm's ability to deliver reliable and cost-effective logistics services

while reducing waste, emissions, and operational inefficiencies associated with logistics activities (Hongsakul & Chuaychoo, 2024). As such, sustainable logistics performance represents a multidimensional construct integrating economic, environmental, and operational outcomes. While prior studies have increasingly emphasized sustainability in logistics, existing research often focuses on individual performance dimensions rather than providing an integrated understanding of sustainable logistics outcomes. In the Thai context, logistics firms continue to encounter sustainability challenges related to infrastructure, operational efficiency, and environmental management (Singhdong, 2020; Faijaidee, 2025).

Prior research suggests that effective coordination, operational flexibility, and responsiveness are important drivers of sustainability outcomes in logistics operations (Malhotra & Kharub, 2024). These capabilities enable firms to optimize resource utilization, reduce operational inefficiencies, and maintain service reliability under dynamic conditions. Accordingly, sustainable logistics performance reflects the combined outcomes of digital integration and adaptive supply chain capabilities in supporting long-term operational and environmental sustainability.

Research Methodology

This study employed a quantitative research design using a survey research approach. The research process followed a systematic sequence, beginning with the identification of the research problem and development of the conceptual framework, followed by the construction of research hypotheses and measurement items derived from the literature. Data were then collected via a structured questionnaire and analyzed using descriptive and inferential statistics to test the proposed hypotheses.

Population, Sample Selection, and Data Collection

The population of this study comprised 445 logistics and transportation firms operating in Thailand, obtained from the Department of Business Development, Thailand (Department of Business Development, 2024). A purposive sampling technique was employed to identify firms with relevant experience in digital supply chain operations. Given the relatively manageable population size, a census approach was adopted, whereby questionnaires were distributed to all firms within the identified population. Data were collected using a postal questionnaire, which included research objectives, demographic questions, measurement items, and instructions for completion. A total of 445 questionnaires were distributed, of which 128 were returned. After screening for completeness and consistency, 112 usable questionnaires were retained for analysis, yielding an effective response rate of 25.17% (112 × 100 / 445), which exceeds the

acceptable threshold for organizational-level survey research (Aaker et al., 2001). To assess potential non-response bias, early and late responses were compared following Armstrong and Overton (1977). The results indicated no statistically significant differences between the two groups at the 95% confidence level ($p > .05$), suggesting that non-response bias was not a concern. In addition, statistical power analysis was conducted using G*Power 3.1 to evaluate the adequacy of the sample size for hypothesis testing. Based on a medium effect size ($f^2 = 0.15$), a significance level of 0.05, and a statistical power of 0.80, the minimum required sample size was 92 observations, which was lower than the obtained sample of 112 firms. These results indicate that the sample size was sufficient for the proposed regression analyses.

Research Instrument

The research instrument employed in this study was a structured questionnaire developed based on an extensive review of the digital supply chain and logistics literature to ensure conceptual clarity and content validity. The questionnaire was designed to measure the key constructs in the proposed research model, including digital supply chain integration, supply chain resilience, supply chain agility, government policy support, and sustainable logistics performance. Measurement items were adapted from well-established empirical studies and refined to reflect the operational context of logistics and transportation firms in Thailand (Zhou et al., 2023; Qi et al., 2022; Ivanov et al., 2019; Kache & Seuring, 2017).

All construct items were measured using a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree. The Likert scale was selected due to its suitability for capturing managerial perceptions and attitudinal responses in organizational research (Hair et al., 2019). The questionnaire consisted exclusively of closed-ended questions to enhance response consistency and facilitate statistical analysis.

Ethical Considerations and Protection of Participants' Rights

This study was approved by the Research Ethics Committee for Human Research of Nakhon Phanom University (Ref. No. HE69-015; Record No. 015/2569) and conducted in accordance with ethical standards for research involving human participants. Participation was voluntary, informed consent was obtained from all respondents, and all information was treated confidentially and reported in aggregate form to ensure anonymity.

Validity and Reliability Assessment

Table 1 Results of Measure Validation

Items	Factor Loadings	AVE	CR	Cronbach Alpha
Digital Supply Chain Integration (DSCI)	0.569 – 0.871	0.563	0.903	0.906
Supply Chain Resilience (SCR)	0.804 – 0.886	0.712	0.921	0.899
Supply Chain Agility (SCA)	0.800 – 0.865	0.687	0.914	0.889
Sustainable Logistics Performance (SLP)	0.608 – 0.836	0.581	0.887	0.870
Government Policy Support (GPS)	0.758 – 0.880	0.668	0.923	0.916

In this study, the validity and reliability of the measurement instrument were rigorously assessed. Table 1 presents the results of factor loadings, average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha coefficients for all constructs included in the study. Confirmatory factor analysis (CFA) was employed to evaluate the relationships among measurement items and their respective latent constructs. The results indicated that factor loadings ranged from 0.569 to 0.886 and were statistically significant, demonstrating satisfactory construct validity. Although one indicator of digital supply chain integration and one indicator of sustainable logistics performance had factor loadings below the recommended threshold of 0.70, both items were retained because the corresponding constructs demonstrated satisfactory convergent validity and composite reliability, exceeding the recommended criteria (Hair et al., 2019). In addition, the retained items were considered theoretically important for capturing the multidimensional nature of digital supply chain integration and sustainable logistics performance. Furthermore, AVE values ranged from 0.563 to 0.712, exceeding the recommended threshold of 0.50, while composite reliability (CR) values ranged from 0.887 to 0.921, indicating strong internal consistency reliability (Hair et al., 2019). Cronbach's alpha coefficients ranged from 0.870 to 0.916, surpassing the commonly accepted threshold of 0.70 (Nunnally & Bernstein, 1994). Overall, these findings confirm that the measurement instrument demonstrates adequate validity and reliability for empirical analysis.

Statistical Technique

Descriptive statistics, including means and standard deviations, were first computed to summarize the characteristics of the data. Pearson correlation analysis was then conducted to examine the preliminary relationships among the study variables. In addition,

variance inflation factors (VIFs) were assessed to detect potential multicollinearity issues, and the results indicated that all VIF values were within acceptable thresholds. To test the proposed hypotheses, Ordinary Least Squares (OLS) regression analysis was employed to examine the direct effects of digital supply chain integration, supply chain resilience, and supply chain agility on sustainable logistics performance. Mediation analysis was also conducted to examine the indirect effects of digital supply chain integration on sustainable logistics performance through supply chain resilience and supply chain agility. The mediation effects were assessed using bootstrapping procedures following Hayes (2018), with 5,000 bootstrap samples and 95% bias-corrected confidence intervals. Moderation effects were tested by incorporating interaction terms between digital supply chain integration and government policy support. Prior to constructing interaction terms, all variables were mean-centered to reduce potential multicollinearity and improve the interpretability of interaction effects (Hair et al., 2019). Although structural equation modeling (SEM) provides a comprehensive framework for latent construct analysis, it generally requires larger sample sizes to ensure estimation stability (Kline, 2011). Given the moderate sample size of 112 firms and the use of composite observed measures, OLS regression was considered a more parsimonious and appropriate method for testing the proposed relationships. In addition, key assumptions of OLS regression, including normality, homoscedasticity, and independence of errors, were examined and satisfactorily met. Harman's single-factor test was also conducted, and the results indicated that no single factor accounted for the majority of the variance, suggesting that common method bias was not a major concern (Podsakoff et al., 2003).

Results

As shown in table 2, the descriptive statistics, bivariate correlations, and variance inflation factors (VIFs) are reported for all variables included in the analysis.

Table 2 Descriptive Statistics and Correlation Matrix

Variables	DSCI	SCR	SCA	GPS	SLP	VIF
Mean	4.10	3.74	3.45	3.65	3.74	-
SD	0.56	0.99	0.95	0.90	0.68	-
DSCI	0.750					1.491
SCR	0.513**	0.844				2.458
SCA	0.464**	0.741**	0.829			2.991
GPS	0.496**	0.569**	0.482**	0.817		1.614
SLP	0.389**	0.402**	0.393**	0.439**	0.762	-

**p<0.01 level (2-tailed)

The mean values range from 3.45 to 4.10, indicating generally favorable perceptions among respondents, while standard deviations suggest an acceptable level of variability across responses. The correlation coefficients among the study variables range from 0.389 to 0.741. These values are below the commonly accepted threshold of 0.80, suggesting that the relationships among constructs are moderate and do not indicate excessive overlap (Hair et al., 2019). Following the Fornell–Larcker criterion, discriminant validity was assessed by comparing the square root of AVE with the inter-construct correlations. The diagonal elements, ranging from 0.750 to 0.844, exceed the corresponding correlations, confirming satisfactory discriminant validity among the constructs (Fornell & Larcker, 1981). To further assess multicollinearity, variance inflation factors (VIFs) were examined to detect potential multicollinearity issues, and the results indicated that all VIF values were within acceptable thresholds. VIF values range from 1.491 to 2.991, which are well below the commonly accepted threshold of 10, indicating that multicollinearity is not a concern in this study (Hair et al., 2019). Overall, these results confirm that the independent variables are sufficiently distinct and suitable for inclusion in the regression analyses, thereby satisfying the necessary conditions for hypothesis testing.

Table 3 Results of Regression Analysis Examining the Effects of Digital Supply Chain Integration and the Moderating Effect of Government Policy Support

Independent Variables	Dependent Variables					
	SCR	SCA	SLP	SLP	SLP	SLP
DSCI	0.857***	0.741***	0.331**			0.467**
	(0.137)	(0.135)	(0.105)			(0.160)
SCR				0.275***		
				(0.060)		
SCA					0.282***	
					(0.063)	
GPS						0.100
						(0.088)
DSCI * GPS						0.094*
						(0.044)
Adjusted R^2	0.256	0.208	0.175	0.174	0.177	0.337
F-statistic	15.284***	11.963***	8.417**	20.982***	19.845***	12.674***

*p<.05, **p<.01, ***p<.001 Beta coefficients with standard errors in parenthesis

Table 3 presents the results of the OLS regression analysis assessing the effects of digital supply chain integration on supply chain resilience, supply chain agility, and sustainable logistics performance, as well as the moderating role of government policy support. Firstly, the results indicate that digital supply chain integration has significant positive effects on supply chain resilience (β = 0.857, $p < .001$), supply chain agility (β = 0.741, $p < .001$), and sustainable logistics performance (β = 0.331, $p < .01$). These findings suggest that higher levels of digital integration enable firms to enhance adaptive supply chain capabilities and improve overall performance outcomes. Therefore, *Hypotheses 1a, 1b, and 1c* are supported. Secondly, the results show that supply chain resilience has a significant positive effect on sustainable logistics performance (β = 0.275, $p < .001$), indicating that firms with stronger capabilities to anticipate and recover from disruptions are better able to sustain operational performance. Therefore, *Hypothesis 2 is supported*. Thirdly, supply chain agility is found to have a significant positive effect on sustainable logistics performance (β = 0.282, $p < .001$), suggesting that the ability to respond quickly to changing conditions contributes to improved logistics efficiency and service outcomes. Therefore, *Hypothesis 4 is supported*. Lastly, regarding the moderating effect, government policy support does not exhibit a statistically significant direct effect on sustainable logistics performance (β = 0.100, $p > .05$). However, the interaction term between digital supply chain integration and government policy support is positive and statistically significant (β = 0.094, $p < .05$), indicating that supportive policy environments strengthen the effectiveness of digital integration in enhancing sustainable logistics performance. Figure 2 further illustrates that the positive effect of digital supply chain integration on sustainable logistics performance becomes stronger under higher levels of government policy support. Specifically, the slope representing high government policy support is steeper than that representing low government policy support, indicating that firms operating under more supportive policy environments are better able to leverage digital supply chain integration to enhance sustainable logistics performance. This finding highlights the important role of supportive institutional conditions in strengthening the effectiveness of firm-level digital integration efforts. Therefore, *Hypothesis 6 is supported*. The adjusted R^2 values range from 0.174 to 0.337, while all regression models exhibit statistically significant F-statistics, indicating satisfactory overall model significance.

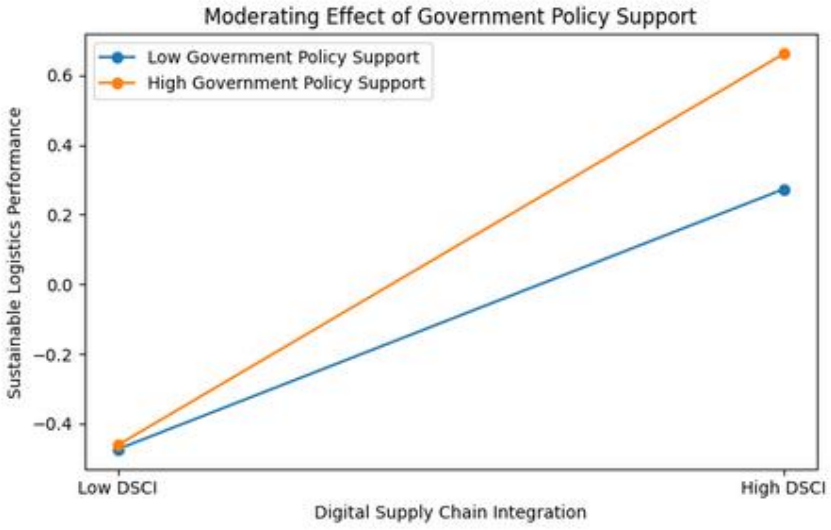

Figure 2 Moderating Effect of Government Policy Support on the Relationship between Digital Supply Chain Integration and Sustainable Logistics Performance

Table 4 Results of Mediation Analysis

Indirect Path	Indirect Effect	Boot SE	95% CI Lower	95% CI Upper	Result
DSCI ⟶ SCR ⟶ SLP	0.118	0.097	-0.061	0.331	Not Supported
DSCI ⟶ SCA ⟶ SLP	0.097	0.091	-0.068	0.295	Not Supported
Total Indirect Effect	0.215	0.067	0.102	0.364	Supported

Note: Bootstrap samples = 5,000; CI = bias-corrected confidence interval.

Table 4 presents the results of the mediation analysis using bootstrapping procedures. The findings indicate that the total indirect effect of digital supply chain integration on sustainable logistics performance through supply chain resilience and supply chain agility is positive and statistically significant (Indirect Effect = 0.215, 95% CI = (0.102, 0.364)). This finding suggests that supply chain resilience and supply chain agility jointly contribute to explaining how digital supply chain integration enhances sustainable logistics performance. However, when examined separately, the indirect effects through supply chain resilience and supply chain agility are not statistically significant because their confidence intervals include zero. Therefore, *Hypotheses 3 and 5 are not supported*. These findings imply that the combined influence of resilience and agility is more important in explaining sustainable logistics performance than the independent effect of either capability alone.

Discussion

The findings related to Hypotheses 1a–1c highlight the central role of digital supply chain integration in shaping both operational capabilities and sustainability outcomes. The results suggest that when logistics firms integrate digital technologies across supply chain activities, they are better able to enhance resilience, improve agility, and achieve higher levels of sustainable logistics performance. Rather than functioning solely as a technological upgrade, digital integration appears to transform how logistics operations are coordinated and managed. This outcome is consistent with prior studies arguing that digitally connected supply chains enable faster information flows, greater transparency, and more effective coordination under uncertainty (Ivanov et al., 2019; Kache & Seuring, 2017). This can be explained by the fact that digital integration enhances real-time visibility and coordination across supply chain partners, enabling firms to anticipate disruptions and respond more effectively to dynamic conditions. In the Thai logistics context, where firms frequently encounter infrastructure constraints and environmental volatility, DSCI emerges as a critical enabler of both adaptive capability development and sustainability-oriented performance. Specifically, limited infrastructure interoperability and frequent operational disruptions in Thailand make digitally integrated systems particularly valuable for improving responsiveness and reducing inefficiencies.

Turning to Hypothesis 2, the results provide evidence that supply chain resilience contributes significantly to sustainable logistics performance. This finding indicates that firms capable of absorbing disruptions and recovering efficiently are more likely to maintain stable logistics operations over time. Resilience reduces the severity and duration of operational interruptions, which in turn limits inefficiencies and unnecessary resource consumption. As a result, resilient logistics systems support not only economic performance but also broader sustainability objectives (Scholten et al., 2020). This relationship can be attributed to the ability of resilient firms to maintain service continuity and avoid costly recovery processes, which are often associated with excessive resource use and environmental impact. This interpretation aligns with earlier research emphasizing resilience as a key mechanism through which firms protect performance under conditions of risk and uncertainty (Ivanov et al., 2019). In the Thai context, where logistics disruptions such as congestion and regulatory delays are common, resilience becomes particularly important in sustaining long-term operational effectiveness.

The results associated with Hypothesis 4 further emphasize the importance of supply chain agility in achieving sustainable logistics outcomes. Agile firms are better positioned to adjust transportation schedules, inventory decisions, and service processes in

response to changing market conditions and customer expectations. Such responsiveness allows firms to reduce operational waste, improve service reliability, and allocate resources more efficiently (Kache & Seuring, 2017). This finding suggests that agility enables firms to continuously realign their operations with demand fluctuations, thereby minimizing inefficiencies and enhancing sustainability performance. In dynamic logistics environments, agility therefore functions as a practical capability that enables firms to balance flexibility with performance stability. This finding supports previous studies that identify agility as a critical driver of logistics performance in fast-changing and competitive markets (Yu et al., 2018). Given the increasing volatility of demand and cross-border logistics activities in Thailand, agility serves as a key mechanism for maintaining competitiveness and service quality.

Regarding Hypotheses 3 and 5, the mediation analysis provides additional insights into the mechanisms through which digital supply chain integration influences sustainable logistics performance. Although the individual indirect effects through supply chain resilience and supply chain agility are not statistically significant, the total indirect effect is positive and significant. This finding suggests that resilience and agility collectively contribute to explaining how digital supply chain integration enhances sustainable logistics performance. Rather than operating independently, these adaptive capabilities appear to work together in supporting firms' responses to dynamic operational conditions and sustainability challenges. This result may indicate that digitally integrated supply chains require the combined presence of resilience and agility to effectively translate digital resources into sustainable logistics outcomes (Teece et al., 1997; Ivanov et al., 2019). In the Thai logistics context, where firms frequently encounter both operational disruptions and fluctuating market demands, the simultaneous development of resilience and agility may therefore be more important than relying on either capability alone. This finding also reinforces the dynamic capability perspective, which emphasizes that organizational capabilities often function in combination to support long-term performance under uncertain environments (Teece et al., 1997; Kache & Seuring, 2017).

Finally, the findings for Hypothesis 6 reveal that government policy support strengthens the relationship between digital supply chain integration and sustainable logistics performance, even though its direct effect on performance is not statistically significant. The non-significant direct effect indicates that policy support alone may not directly improve logistics sustainability without complementary firm-level capabilities. This finding implies that firms must actively pursue digital integration initiatives to fully benefit from supportive institutional environments. However, when supportive policies, such as

digital infrastructure development, regulatory facilitation, and innovation incentives, are present, firms are better able to translate digital integration into tangible sustainability outcomes (Baah et al., 2024; Zhao & Liu, 2024). This can be explained by the complementary relationship between institutional support and organizational capabilities, where policy acts as an enabling condition rather than a direct performance driver. This interaction highlights the complementary nature of institutional support and firm-level capabilities, particularly in emerging economies where policy environments can either accelerate or constrain digital transformation (Haqqi, 2023). In the Thai context, government initiatives such as digital infrastructure development and logistics policy reforms play a crucial role in enhancing the effectiveness of firm-level digital strategies, rather than directly driving performance outcomes.

Implication

Theoretical Implications

This study provides several important theoretical contributions to the literature on digital supply chain management and sustainable logistics performance.

1. The findings extend dynamic capability theory by demonstrating that digital supply chain integration functions as a higher-order capability that enables firms to strengthen adaptive supply chain capabilities, particularly resilience and agility, which subsequently support sustainable logistics performance. While prior studies have often emphasized digital technologies as operational or technological tools, this study highlights their strategic role in enhancing firms' ability to sense disruptions, respond to uncertainty, and reconfigure logistics operations under dynamic environments. The findings further suggest that resilience and agility jointly support the translation of digital integration into sustainability-oriented outcomes, thereby reinforcing the view that organizational capabilities frequently operate in combination rather than independently within the dynamic capability framework.

2. This study contributes to the literature by clarifying the complementary relationship between organizational capabilities and institutional support. The findings reveal that government policy support does not directly influence sustainable logistics performance but instead strengthens the effectiveness of digital supply chain integration. This result advances existing research by positioning policy support as an enabling condition rather than a direct performance driver, thereby extending contingency theory by demonstrating how external institutional conditions influence the effectiveness of firm-level digital capabilities. The findings suggest that external institutional conditions can enhance

the effectiveness of firm-level digital capabilities, particularly in environments characterized by uncertainty and technological transition.

3. This study further enriches the literature by providing empirical evidence from an emerging economy context, specifically Thailand. The findings demonstrate that digital supply chain integration plays a particularly critical role in environments characterized by infrastructure limitations and operational uncertainty. This contextual contribution enhances the generalizability of dynamic capability theory by showing how its mechanisms operate under resource-constrained and institutionally evolving conditions.

Managerial Implications

The findings of this study offer several actionable implications for managers in logistics and transportation firms.

1. Managers should prioritize the implementation of integrated digital technologies, such as real-time tracking systems, cloud-based information sharing platforms, and analytics tools, to improve visibility, coordination, and information sharing across supply chain partners. These technologies can strengthen both resilience and agility, enabling firms to respond more effectively to operational disruptions and changing market demands.

2. Firms should invest in capability development programs that strengthen supply chain resilience and agility. This includes establishing contingency planning systems, developing flexible logistics operations, and training employees to respond rapidly to unexpected changes. By doing so, firms can maintain service continuity while minimizing inefficiencies and resource waste.

3. Managers should actively leverage government support initiatives, such as digital infrastructure programs, regulatory facilitation, and innovation incentives. Rather than relying solely on policy support, firms should align these external resources with their internal digital strategies to maximize performance outcomes. In this regard, policy support should be viewed as a complementary enabler that enhances, rather than replaces, firm-level capabilities.

4. Firms operating in emerging markets should design digital strategies that are compatible with local operational conditions, including infrastructure limitations and regulatory complexity. Managers should therefore emphasize scalable and flexible digital solutions that can operate effectively under uncertain conditions while simultaneously enhancing operational adaptability and long-term sustainable logistics performance.

Limitations and Suggestions for Future Research

Despite its contributions, this study has several limitations that provide directions for future research.

1. This study adopts a cross-sectional research design using OLS regression with composite measures, which may limit the ability to capture the dynamic evolution of digital supply chain capabilities over time and restrict causal inference. As firms continuously adapt to changing environments, the observed relationships may vary across different stages of digital transformation. Future research is therefore encouraged to employ longitudinal designs to better understand how digital integration and its associated capabilities develop over time.

2. The use of OLS regression with observed composite measures may limit the ability to simultaneously assess measurement and structural relationships. Future research could apply Structural Equation Modeling (SEM) to provide a more comprehensive evaluation of latent constructs and their interrelationships.

3. This study relies on self-reported data collected from a single source, which may introduce common method bias despite the procedural and statistical remedies applied. Future research may address this limitation by using multi-respondent data or combining survey data with objective performance indicators.

4. The use of purposive sampling and the focus on Thai logistics and transportation firms may limit the generalizability of the findings to other institutional contexts. Future research is encouraged to employ probability sampling techniques and cross-country comparative designs to examine how differences in regulatory frameworks and digital infrastructure influence the effectiveness of digital supply chain integration.

5. Although this study identifies supply chain resilience and agility as key mechanisms linking digital integration to sustainable logistics performance, additional organizational and contextual factors may further explain variations in performance outcomes. Future research could extend this model by incorporating variables such as digital leadership, organizational learning, technological readiness, and inter-organizational collaboration. Moreover, the increasing adoption of emerging technologies, including artificial intelligence and blockchain, warrants further investigation into their roles in shaping supply chain integration and performance.

.....

References

Aaker, D. A., Kumar, V., & Day, G. S. (2001). *Marketing research* (7th ed.). John Wiley & Sons.

Al-Khatib, A. & Ramayah, T. (2024). Artificial intelligence-based dynamic capabilities and circular supply chain: Analyzing the potential indirect effect of frugal innovation in retailing firms. *Business Strategy and the Environment*, *34*(1), 830-848. https://doi.org/10.1002/bse.4018

Armstrong, J.S. & Overton, T.S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396-402.

Baah, C., Agyabeng-Mensah, Y., Afum, E., Acquah, I. S. K., & Essel, D. (2024). Government influence on logistics and supply chain innovations: Assessing implications for firm performance and societal impact in an emerging economy. *International Journal of Emerging Markets, 19*(11), 3646–3666. https://doi.org/10.1108/IJOEM-09-2021-1348

Bag, S., Wood, L. C., Xu, L., Dhamija, P., & Kayikci, Y. (2022). Big data analytics as an operational excellence approach to enhance sustainable supply chain performance. *International Journal of Production Economics, 243*, 108320. https://doi.org/10.1016/j.resconrec.2019.104559

Ciampi, F., Demi, S., Magrini, A., Marzi, G., & Papa, A. (2021). Exploring the impact of big data analytics capabilities on business model innovation: The mediating role of entrepreneurial orientation. *Journal of Business Research, 123*, 1–13. https://doi.org/10.1016/j.jbusres.2020.09.023

Department of Business Development. (2024). *Business data warehouse*. http://datawarehouse.dbd.go.th/bdw/home/main.html [in thai]

Faijaidee, W. (2025). Exploring the challenges of green supply chain initiatives in Thailand. *Logistics, 9*(1), 12. https://doi.org/10.3390/logistics9010012

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 18(1), 39-50.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Haqqi, H. (2023). The government's policy in encouraging the global competitiveness of Indonesian MSMEs through the digital ecosystem. *Journal of Economics Management and Trade*, *29*(8), 66-76. https://doi.org/10.9734/jemt/2023/v29i 81115

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.

Hongsakul, B. & Chuaychoo, I. (2024). The influence of logistics activity on sustainable performance of air cargo business in Thailand. *Abac Journal*, *44*(4), 176-197. https://doi.org/10.59865/abacj.2024.45

Ivanov, D., Dolgui, A., Das, A., & Sokolov, B. (2019). Digital supply chain twins: Managing the ripple effect, resilience, and disruption risks by data-driven optimization, simulation, and visibility. In D. Ivanov, A. Dolgui, & B. Sokolov (Eds.), *Handbook of ripple effects in the supply chain* (pp. 309–332). Springer. https://doi.org/10.1007/ 978-3-030-14302-2_15

Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of big data analytics and supply chain management. *International Journal of Operations & Production Management, 37*(1), 10–36. https://doi.org/10.1108/IJOPM-02-2015-0078

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). Guilford Press.

Le, T. T., & Fan, Y. (2023). Supply chain digitalization and sustainable performance: The role of dynamic capabilities and organizational processes. *Sustainability, 15*(4), 3278. https://doi.org/10.3390/su15043278

Malhotra, G. & Kharub, M. (2024). Elevating logistics performance: Harnessing the power of artificial intelligence in e-commerce. *The International Journal of Logistics Management*, *36*(1), 290-321. https://doi.org/10.1108/ijlm-01-2024-0046

Mohaghegh, M., Blasi, S., Russo, I., & Baldi, B. (2025). Digital transformation and sustainable performance: The mediating role of triple-A supply chain capabilities. *Journal of Business & Industrial Marketing, 40*(4), 896–910. https://doi.org/10.1108/JBIM-02-2023-0098

National Economic and Social Development Council (NESDC). (2023). *Thailand logistics report 2021*. Office of the Prime Minister, Thailand.

Nunnally, J.C. & Bernstein, I.H. (1994). *Psychometric theory* (3rd ed). McGraw-Hill.

Ogunwole, O., Onukwulu, E. C., Joel, M. O., Ewim, C. P. M., & Adaga, E. M. (2024). Digital transformation in supply chain management: Leveraging blockchain for transparency and sustainability. *Iconic Research and Engineering Journals, 8*(3), 848–857.

Peng, P. & Sun, M. (2024). Government subsidies and corporate environmental, social and governance performance: evidence from companies of China. *International Studies of Economics*, *19*(3), 374-405. https://doi.org/10.1002/ise3.79

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Qi, Y., Wang, X., Zhang, M., & Wang, Q. (2022). Developing supply chain resilience through integration: An empirical study on an e-commerce platform. *Journal of Operations Management*, *69*(3), 477-496. https://doi.org/10.1002/joom.1226

Scholten, K., Stevenson, M., & Van Donk, D. P. (2020). Dealing with the unpredictable: Supply chain resilience. *International Journal of Operations & Production Management*, *40*(1), 1-10. https://doi.org/10.1108/IJOPM-01-2020-789

Singhdong, P. (2020). *Digital transformation factors influencing the sustainability of logistics service providers in Thailand* [Doctoral dissertation, Chulalongkorn University]. Chulalongkorn University Thesis and Dissertations. https://digital.car.chula.ac.th/chulaetd/463

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Teixeira, A. R., Ferreira, J. V., & Ramos, A. L. (2025). Intelligent supply chain management: A systematic literature review on artificial intelligence contributions. *Information, 16*(5), 399–439. https://doi.org/10.3390/info16050399

Yu, W., Chavez, R., Jacobs, M. A., & Feng, M. (2018). Data-driven supply chain capabilities and performance: A resource-based view. *Transportation Research Part E: Logistics and Transportation Review, 114*, 371–385. https://doi.org/10.1016/j.tre.2017.04.002

Zhao, J., & Liu, X. Y. (2024). ICT, supply chain digital integration capability, and firm financial performance: The antagonistic effects of perceived government support and cognitive constraints on digital transformation. *SAGE Open, 14*(2), 21582440241241887. https://doi.org/10.1177/21582440241241887

Zhou, H., Wang, Q., Li, L., Teo, T., & Yang, S. (2023). Supply chain digitalization and performance improvement: A moderated mediation model. *Supply chain Management an International Journal*, *28*(6), 993-1008. https://doi.org/10.1108/scm-11-2022-0434