



Digital vs. Traditional Supply Chain Management Strategies Trade-offs: A Contingency Framework

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Article Info

ISSN (online): 2583-6641

Volume: 04

Issue: 04

July - August 2025

Received: 03-04-2025

Accepted: 02-05-2025

Published: 16-05-2025

Page No: 01-07

Abstract

In an increasingly interconnected global economy, supply chain modernization is crucial for businesses. Digital transformation can enhance supply chain resilience, yet few firms are satisfied with their digitization efforts. Integrating digital technologies into supply chain management presents both opportunities and challenges, making the choice between digital and traditional strategies contingent on contextual factors. This requires a nuanced understanding of the trade-offs between approaches. This study uses a descriptive research design to explore this issue in detail. A comprehensive literature review synthesizes existing knowledge and develops a contingency framework, manifested as research propositions, for digital versus traditional supply chain management strategies. Future research can empirically validate these propositions by exploring the relationships between contingency factors, strategic choices, and supply chain performance.

DOI: <https://doi.org/10.54660/IJMOR.2025.4.4.1-7>

Keywords: Contingency Framework, Digital Supply Chain, Traditional Supply Chain, Supply Chain Resilience, Supply Chain Management Strategies

Introduction

Global disruptions such as COVID-19 and geopolitical tensions have exposed vulnerabilities in traditional supply chain management, accelerating digital adoption for resilience and agility ^[1-3]. These disruptive events have underscored the critical need for supply chains to be not only efficient but also resilient, capable of adapting to unforeseen circumstances ^[4,5].

Over time, supply chain management has evolved from a functional necessity to a critical strategic function, essential for organizational success in today's dynamic and interconnected global marketplace ^[6]. Supply chain management encompasses the strategic oversight of the flow of goods, information, and finances, aiming to enhance efficiency, minimize costs, and elevate customer satisfaction ^[7]. Traditional supply chains, characterized by established processes and hierarchical structures, are now being juxtaposed against digital supply chains, which leverage advanced technologies to foster agility, transparency, and responsiveness ^[8].

Traditional supply chains, while often perceived as rigid, offer stability and predictability, particularly in well-established markets with reliable infrastructure ^[9]. Digital supply chains, conversely, promise enhanced visibility and real-time decision-making, albeit with the challenges of implementation and integration ^[10]. Yet, 60% of firms struggle to justify return on investment (ROI) on digital investments ^[11], while others cling to legacy systems.

The adoption of digital technologies in supply chain management is not merely a technological upgrade but a strategic imperative for firms seeking to thrive in an increasingly competitive and dynamic global landscape ^[12]. Moreover, as businesses navigate the complexities of supply chain digitalization, it is crucial to acknowledge the potential for unintended consequences ^[13]. This involves assessing the influence of digital transformation on supply chain resilience and how firms can strategically develop resilient supply chains to navigate highly uncertain market conditions ^[14].

Therefore, to navigate the complexities of digital and traditional supply chain management strategies, a contingency framework is needed that considers various trade-offs.

Such a framework should enable organizations to make informed decisions about which approach or combination of approaches best suits their specific context, goals, and risk tolerance. This conceptual paper delves into the trade-offs inherent in adopting digital versus traditional supply chain management strategies, advocating for a contingency framework that tailors the approach to specific organizational contexts and environmental dynamics.

Literature Review

Traditional Supply Chain Strategy

The foundation of supply chain management lies in the integration of operations, materials, and logistics management into a cohesive, value-driven process ^[15]. Traditional supply chain strategies emphasize cost reduction through economies of scale, efficient resource allocation, and optimized inventory management ^[15]. These strategies often involve long-term contracts with suppliers, standardized processes, and a focus on forecasting demand to minimize stockouts and overstocking. The efficient flow of products, finances, and information characterizes these conventional models ^[16].

However, traditional supply chains frequently grapple with information silos, limited visibility, and slow response times to unforeseen disruptions ^[15]. These conventional approaches often rely on historical data and manual processes, which can lead to inaccuracies in demand forecasting and suboptimal resource allocation ^[17]. Furthermore, the globalization of businesses amplifies the complexity of extended networks, thereby exacerbating the negative consequences of potential disruptions ^[18].

Digital Supply Chain Strategy

Digital technologies are reshaping industries, impacting business models ^[19]. The rise of digitalization is driven by the increasing prominence of information technology in innovation strategies ^[20]. It impacts various aspects of businesses, including supply chains, and can provide solutions to supply chain challenges ^[21]. Specifically, there is a growing demand for businesses to uphold transparency, expedite delivery processes, and deliver personalized customer experiences ^[22]. Digital systems enhance information management across the supply chain, allowing data to accumulate from each phase ^[23], which in turn enhance supply chain integration, planning, and control, ultimately increasing overall supply chain surplus ^[24].

Modern technologies are gaining importance in supply chain management, transforming network structure, business processes, and management components ^[25]. Digital technologies systematically transform business operations using the Internet (Internet of Things/IoT), big data, and Artificial Intelligence (AI). The central tenet of digital transformation extends beyond mere technological integration; it signifies a comprehensive paradigm shift that necessitates the assimilation of digital technologies into every facet of an enterprise, thereby revolutionizing operational modalities, strategic orientations, and value propositions ^[26]. Zhao *et al.* (2023) ^[14] stated that firms are utilizing digital transformation to enhance resilience in supply chains, providing insights to leverage digitalization.

Digital supply chain management has emerged as a strategic imperative for organizations seeking to enhance efficiency, responsiveness, and resilience ^[27] in an increasingly complex and dynamic global marketplace. Digitalizing supply chain

networks could lead to significant benefits in terms of value creation, cost reduction, and enhanced resilience ^[28]. By leveraging advanced technologies such as IoT, blockchain, and AI, businesses can gain unprecedented visibility into their supply chains, optimize operations, and create new sources of value ^[29]. The integration of digital technologies can enhance information processing speed and response capabilities, which enhances supply chain management transparency and collaboration ^[30].

Nevertheless, the impact of digital transformation on supply chain competitive performance has triggered considerations due to the strong dependence on digital technology resources ^[31]. Embracing digital supply chains necessitates adjusting to new trends and innovations to remain competitive as digital transformation requires adapting to the turbulent environment and changing requirements of interested parties, enabling organizations to develop a competitive advantage, decrease operational costs, and increase efficiency ^[32]. Furthermore, it necessitates the cultivation of a digitally literate workforce, capable of harnessing the power of data analytics, and other emerging technologies to drive informed decision-making and optimize supply chain performance ^[33, 34].

Contingency Theory

The contingency theory posits that organizational effectiveness depends on aligning organizational characteristics with situational demands ^[35]. This perspective suggests that there is no universally superior, or one-size-fits-all, way to organize or manage. Instead, the most effective approach is contingent upon the specific circumstances facing the organization. Contingency theory suggests plans differ for each company based on environmental variables, stating there isn't a single approach to managing an organization ^[36]. Contingency theory is used to develop optimal supply chain strategies that are based on a variety of contextual factors.

As markets become more dynamic, businesses must continuously assess and refine their supply chain strategies. Sutia (2022) ^[37] discusses how integrating supply chain management with marketing initiatives can enhance competitive advantage and responsiveness to varying consumer demands. Moreover, the advancement of technologies like automation, blockchain, and advanced analytics is crucial for fortifying supply chains against economic fluctuations and enabling operational continuity ^[38]. This digital evolution supports the idea that organizations must deploy these technologies in response to specific challenges posed by their environments, including market dynamics and competitive intensity ^[39].

The application of contingency theory becomes evident when considering the unique drivers of each market sector. For instance, companies in the green supply chain space are encouraged to adapt their operations in response to environmental regulations and market trends focused on sustainability (see ^[40, 41]). These dynamic adjustments empower firms to respond effectively to shifting consumer preferences and regulatory requirements, thereby maintaining competitive viability. Dubey *et al.* (2019) ^[42] argue that leveraging big data and predictive analytics can significantly enhance manufacturing performance by informing more strategic decision-making processes in supply chain management.

In essence, a nuanced understanding of when and how to

deploy digital solutions in supply chain operations is pivotal for organizations striving to optimize their performance in an ever-changing global marketplace. The interplay between market conditions, technological innovations, and organizational adaptability is framed by a robust theoretical underpinning, encouraging businesses to embrace flexibility and continuous improvement in their operational strategies^[43]. This alignment not only furthers supply chain strategic objectives but also promotes its resilience in fluctuating market environments.

Research Methodology

This study employs a descriptive research design, facilitating a thorough exploration of supply chain management strategies that juxtapose digital and traditional paradigms. This design enables the identification of trade-offs, benefits, and limitations inherent in each approach, highlighting the significance of digital transformations in supply chain management.

To synthesize existing knowledge, this conceptual study relies extensively on a comprehensive literature review methodology to inform the development of a contingency framework for managing supply chains in both spheres. The study draws from a wide range of academic and practitioner literature, as exemplified by Pérez-Salazar *et al.* (2017)^[44], who analyze the role of knowledge management in organizational SCM effectiveness, thus underscoring the importance of integrating knowledge as a strategy to bridge gaps between digital and traditional practices.

The rigorous literature review was conducted through extensive searches across multiple databases, including Scopus, Web of Science, and Google Scholar, to curate relevant academic articles and case studies that underpin this analysis. Furthermore, the comprehensive expertise showcased in the selected literature facilitates the extraction of key themes that portray the complexities and integration of strategies within the supply chain management domain.

The primary objective of this study is to elucidate the major trade-offs, benefits, and limitations of traditional versus digital supply chain strategies. This study constructs a cohesive narrative that integrates findings from multiple scholarly articles to reinforce the transformation of supply chains in the digital age while drawing lessons from traditional methodologies. By proposing a set of propositions derived from the literature, this study anticipates guiding future inquiries into effective supply chain management practices.

Discussion

Core Elements of Supply Chain Digitalization

The dichotomy between digital and traditional supply chains is not merely a matter of technology adoption; it represents a fundamental shift in strategic orientation. Traditional supply chains typically rely on linear, sequential processes, with information flow often delayed and fragmented^[10]. Digital supply chains, in contrast, utilize interconnected networks facilitated by technologies such as IoT, blockchain, and AI, enabling seamless data exchange and collaborative decision-making^[22].

The transition from traditional to digital supply chains involves navigating implementation challenges and harnessing opportunities^[13]. Embracing digital technologies

necessitates significant investment costs, which may deter some companies from pursuing digitalization^[29]. Chen and Tang (2024)^[45] argue that the core of supply chain digitalization lies in cross-organizational digital links to achieve information systems integration, which requires collaborative efforts across the supply chains.

Contingency Factors Influencing Supply Chain Management Strategies

The shift towards digital supply chain management is propelled by the increasing complexity and uncertainty in today's business environment, characterized by demanding customers, globalization, shorter product life cycles, and rapid technological advancements^[46]. However, the suitability of a digital versus traditional approach is not universal but rather depends on several contingency factors^[47]. One of the primary contingency factors is the nature of the product or service being offered, as products with short life cycles and unpredictable demand may benefit more from the agility and responsiveness offered by digital supply chains, while stable products with predictable demand may still be efficiently managed using traditional methods^[48,49]. Thus, the following proposition is suggested:

P1. Firms operating in dynamic and competitive industries are more likely to benefit from digital supply chain management strategies, while those in stable industries may find traditional approaches more suitable.

The level of customization required is another critical factor, with highly customized products necessitating the real-time information sharing and flexible manufacturing capabilities enabled by digital technologies like additive manufacturing^[50]. Another contingency factor involves supply chain complexity, as extended global supply chains with multiple tiers of suppliers and distributors can leverage digital solutions for enhanced visibility and coordination, whereas simpler, localized supply chains may not justify the investment in complex digital systems. Thus, the following proposition is suggested:

P2. Companies with complex global supply chains will experience greater performance improvements from digital supply chain management solutions compared to those with simpler, localized supply chains.

Moreover, the competitive landscape and industry dynamics play a significant role, with companies in highly competitive industries needing to embrace digital supply chain management to gain an edge in terms of speed, cost, and innovation, while those in more stable industries may adopt digital technologies at a slower pace. Furthermore, internal organizational factors, such as the company's technological capabilities, financial resources, and risk appetite, also influence the choice between digital and traditional supply chain management strategies^[51]. Ultimately, the effectiveness of any supply chain management strategy hinges on its alignment with these contingency factors and the firm's ability to adapt its approach as these factors evolve^[36]. Thus, the following proposition is suggested:

P3. The effectiveness of digital supply chain management strategies is contingent on the alignment between technology investments, organizational capabilities, and the specific requirements of the product or service being offered.

Figure 1 below shows the proposed relationship framework of above research propositions.

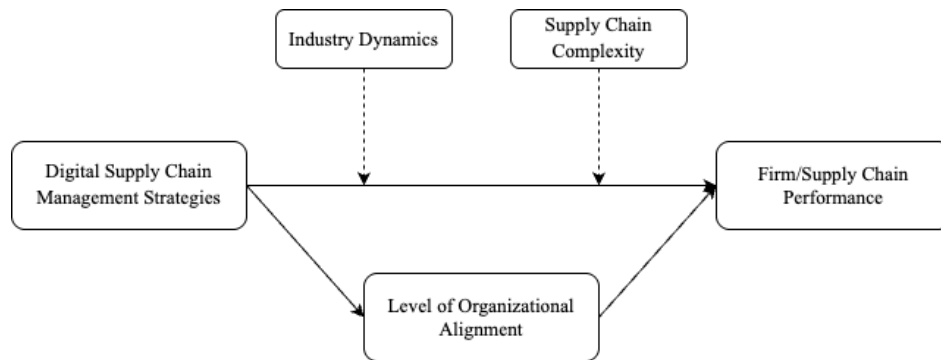


Fig 1: SCM Strategies Contingency Framework

Digital vs. Traditional Strategic Trade-Offs

The strategic trade-offs between traditional and digital supply chain management reflect multifaceted considerations. For instance, traditional supply chains excel in stability and cost-effectiveness; however, they often struggle to effectively adapt to rapid changes, leading to inefficiencies [52]. Digital supply chains, with their integrated technologies, can provide faster reaction times to shifting demands, thereby enhancing supply chain resilience [14]. Furthermore, studies have indicated that the integration of digital technologies allows firms to develop superior operational strategies, thus mitigating the limitations typically associated with traditional supply chains [14, 53].

Digital transformation requires implementing digital technologies in traditional processes [54]. Although digital transformation offers compelling advantages such as enhanced efficiency, visibility, and responsiveness, it also presents several trade-offs compared to traditional supply chain management approaches [27]. Hence, organizational and operational transformation are facing difficulty in taking a step [55]. Lee (2021) [56] added that only a small percentage of firms are satisfied with their approaches to supply chain digitization, despite recognizing its value.

One significant trade-off is the initial investment cost, as implementing digital technologies like IoT sensors, cloud computing, and blockchain can be expensive, requiring a substantial upfront investment that may not be feasible for all organizations. The costs associated with transitioning to digital frameworks may elevate overall expenditures initially, acting as a deterrent for some organizations [57]. Furthermore, the implementation of these technologies requires specialized skills and expertise, which may necessitate investing in training and development programs or hiring new talent. Moreover, as organizations increasingly rely on digital solutions, they expose themselves to new types of risks, notably cybersecurity threats [58–60]. Research suggests that these vulnerabilities demand a proactive and comprehensive cybersecurity strategy, particularly in digital supply chains where the interconnectedness of systems can create points of failure that traditional supply chains may not encounter [59]. Implementing effective cybersecurity measures is essential not only to protect sensitive data but also to maintain stakeholder trust and ensure ongoing operational integrity in the face of evolving cyber threats [58, 60].

Ultimately, digital and traditional supply chain management strategies represent fundamentally different approaches to coordinating the flow of goods, information, and finances across the supply chain, each with distinct trade-offs that organizations must carefully consider. The transition to digital supply chains necessitates a careful evaluation of the

trade-offs between traditional stability and digital agility. As organizations weigh these considerations, they must strategically address cost implications and manage the inherent cybersecurity risks to capitalize on the benefits that digitalization offers for improved supply chain performance and resilience.

Research Limitations

While this study provides a comprehensive conceptual analysis of digital and traditional supply chain management strategies, several limitations must be acknowledged:

- 1. Methodological Constraints:** As a descriptive, literature-based study, the findings rely on secondary data and prior publications, which may introduce selection bias or omit emerging trends not yet captured in academic literature. The absence of primary empirical data (e.g., surveys, interviews) limits the ability to validate the proposed contingency framework in real-world settings.
- 2. Scope and Generalizability**
 - The focus on high-impact journals and databases may exclude relevant grey literature or non-English publications, potentially overlooking regional or industry-specific insights.
 - The trade-offs and hybrid strategies discussed are context-dependent. As the majority of reviewed literatures' objects are large enterprises, reducing generalizability of the proposed framework across all organizational scales.
- 3. Subjectivity in Synthesis:** Thematic extraction and proposition development involve interpretive judgment, which, despite rigorous review protocols, could reflect the researcher's perspectives more than a universally objective consensus.

Conclusion

The core argument advanced is that the optimal choice between digital and traditional supply chain strategies is not a binary one, but rather a contingent decision shaped by factors such as industry characteristics, product type, market volatility, and organizational capabilities. Organizations can build their competitive position on knowledge and innovation by using digital technology to transform their businesses, products, and services. However, digital transformation in supply chain management can be hindered by barriers such as a lack of urgency, absence of industry-specific guidelines, shortage of digital skills and talent, and high implementation costs. In turn, strategic planning, talent pool, brand value,

corporate culture, and technological features are becoming irreplaceable.

Theoretical Contribution

While digital supply chains offer the potential for enhanced resilience and sustainability, the journey toward digitalization requires careful planning, strategic alignment, and a deep understanding of the trade-offs involved. In light of these observations, this research contributes to the literature by offering a conceptual framework that elucidates the trade-offs between digital and traditional supply chain strategies, thereby guiding managers in making informed decisions aligned with their specific organizational context and strategic objectives. Therefore, the decision to implement a digital supply chain should be made based on a comprehensive understanding of the aforementioned trade-offs, which includes an evaluation of the organization's risk tolerance, as well as its ability to manage the inherent risks of digital transformation.

Future Research Agenda

Ultimately, the propositions presented offer a basis for future research to empirically validate the relationships between contingency factors, strategic choices, and supply chain performance. Future studies could also explore the moderating effects of organizational culture and leadership on the adoption and implementation of digital supply chain strategies. Such investigations could involve surveys, case studies, and simulation modeling to capture the complexities of real-world supply chain environments. The study of these propositions through quantitative and qualitative research methodologies will contribute to a more nuanced understanding of the complex dynamics between digital and traditional supply chain management strategies.

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