FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE ERA OF NETWORK COMPETITION: TOWARD A NEW GENERATION OF NETWORKED SUPPLY CHAIN MANAGEMENT SYSTEMS IMPROVING OPERATIONAL PERFORMANCE

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by

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To: Dean William Hardin
College of Business

This dissertation, written by Lisandro E. Sciutto, and entitled The Era of Network Competition: Toward a New Generation of Networked Supply Chain Management Systems Improving Operational Performance, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Florida International University, 2023

DEDICATION

To my wife, Carina, and our son, Cristóbal, who are lifelong learners and inspired me to pursue my desire to be a researcher.

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ABSTRACT OF THE DISSERTATION

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In today's highly competitive markets, firms have realized they no longer compete as independent entities but as business networks. This study contributes to the evolution of supply chain integration knowledge. It also raises awareness among practitioners of using a new generation of networked supply chain management systems (networked-SCMS) combined with information management. This combination allows firms to join multi-enterprise supply chain business networks and build more robust supply chains for their businesses. The research model uses organizational information processing theory to match information needs and leverage lateral relationships inside and outside the organization, to reduce uncertainty among firms. It develops hypotheses to identify the moderation effects of information management and networked-SCMS on supply chain integration, testing for a positive impact on improving operational performance. The research tested the hypotheses using a sample of 245 responses from supply chain professionals to determine how their supply chain processes impact production flexibility, customer services, and operational performance. The findings provided

evidence and relevance to studying and adopting networked-SCMS as the next important milestone in the evolution of supply chain integration. The results revealed the positive effects of networked-SCMS and information management in the relationship between supply chain integration and operational performance. These findings provide a more theoretical and grounded explanation for firms that want to join multi-enterprise supply chain business networks, thus entering the era of network competition, delivering superior value in the marketplace and prevailing over their competitors.

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CHAPTER I. INTRODUCTION

In today's highly competitive markets, firms have realized they no longer compete as independent entities but as supply chain networks. Christopher (2016) identifies this business model shift as the era of network competition. Where firms organize toward a business goal, creating a supply chain community that operates under collaborative behaviors can provide better service quality, faster response to changing conditions, and delivery at a lower cost to serve their customers (Wu, Chuang & Hsu, 2014). In this landscape, the role of digitization and the digital supply chain is crucial for the evolution of the enterprise (Büyüközkan & Göçer, 2018). Some firms are already adapting their organizational design, information system strategy, and processing model to achieve these objectives by joining multi-enterprise supply chain business networks. These networks allow them to manage, coordinate, automate, and build long-term collaborative relationships with their partners (Wu et al., 2014). Although, multi-sided platforms are not new and have been under study for quite some time. It is not until recent years, with the advent of business-to-consumer (B2C) platform ecosystems such as Uber and Airbnb, that they have been studied in B2C settings like the sharing economy (Eckhardt, Houston, Jiang, Lamberton, Rindfleisch & Zervas, 2019), but not in business-to-business environments. Technology-enabled multi-sided platforms for the supply chain ecosystem remain scantily studied, opening the opportunity to investigate the effects of digital technologies on supply chain integration, interfirm collaboration, and the impact on operational performance (Industrial Marketing Management, 2021).

Digitization of the enterprise started decades ago. Information technology has powered business competition, and over the past fifty years, the enterprise software industry has played an essential role in organizational design, impacting people's work (Galbraith, 1974). Enterprise software vendors like SAP introduced ERP (enterprise resources planning) systems capable of integrating the different areas inside a firm. The ERP provided a significant step toward internal integration and organizational design (SAP, 2022b). However, the efficiencies built during years of evolving ERP systems are still restricted to the firm's boundaries. This limits a firm’s ability to connect and collaborate efficiently with other firms and to address their current and future requirements to join networked systems (Agostinho, Ducq, Zacharewicz, Sarraipa, Lampathaki, Poler & Jardim-Gonçalves, 2016).

Some enterprise software vendors recognized this business limitation and have started to evolve their ERPs by integrating them with supply chain applications. The result is a new generation of networked supply chain management systems (networked-SCMS) with embedded supply chain integration (SCI) capabilities (Infor, 2021; SAP, 2022a). Supply chain networks are complex socio-technical adaptive systems that involve both physical systems and interdependent human actors (Behdani, 2012; Carter, Rogers & Choi, 2015), requiring a new digitization approach. Networked-SCMS can manage internal and external information processing requirements, helping firms plug into supply chain business networks and facilitating the work of many people in these organizations who must orchestrate multi-enterprise processes (Titze & McNeill, 2021). A supply chain involves physical systems (transportation, warehousing, logistics, and interfirm connectivity), as well as a social network of interdependent firms (buyers, suppliers, manufacturers, and customers). Firms can meet supply chain requirements using this new generation of enterprise software platforms as networked competition evolves (Agostinho et al., 2016).

Pioneer enterprises are implementing changes in information system strategy and processing models to expand their business processes outside the enterprise's four walls by adopting some form of networked-SCMS (Infor, 2021). They are digitally integrating with their supply chain partners, delivering superior value in the marketplace, and prevailing over their competitors. Furthermore, early adopter firms continue evolving their organizational and information technology (IT) designs to specialize in the supply chain, thus maximizing their differential advantage and overcoming supply chain integration barriers. Supply chain communities create value by exchanging information in the network via integrated multi-firm business flows that support decisions among people and systems. Therefore, information management is central to successful supply chain relationships and collaborative business decisions (Sundram, Bahrin, Munzir & Zoilat, 2018). The information flows across the business network are shaping organizational design. Firms adopt information processing models to reduce uncertainty while interacting with other firms in the network (Galbraith, 1974). The exchange and management of information are at the core of these new networked-SCMS. The value proposition of these networked-SCMS is that they coordinate the goals (better, faster, cheaper, closer) across independent firms in the supply chain community, improving operational performance while minimizing the effect of IT sunk costs that are commonly found on system-to-system integrations.

On the other hand, some firms continue the traditional supply chain integration approach, developing system-to-system capabilities that use non-sustainable IT integrations and proprietary resources to share information flows. Agostinho et al. (2016) point out that changes in one of the firm's competencies and IT landscape pose an ongoing maintenance challenge. Obsolete technology negatively affects system-to-system integrations in vertically integrated firms, because of the ongoing sunk costs of maintenance and utilization (Helfat & Campo-Rembado, 2016). Traditional ERPs defer SCI capabilities, providing only tools to achieve system-to-system data integration between firms, but not providing sustainable and rich enterprise interoperability of networked systems that help meet new system requirements as networked competition evolves (Agostinho et al., 2016).

In contrast, firms implementing networked-SCMS applications have initial costs to join a supply chain network platform but have far less ongoing maintenance costs. Changes in the firm's competence and IT landscape only affect the firm, not the dyad (buyer-supplier) or triad (buyer-supplier-supplier), unlike when these firms use system-to-system integrations. From this perspective, adopting networked-SCMS applications reduces the costs and complexities of IT customizations, providing business agility and flexibility to join different supply chain communities toward new business goals, and improving the firm's operational performance.

This research contributes to the evolution of supply chain integration knowledge and raises awareness of adopting multi-enterprise supply chain business networks. It explores the effects of using networked-SCMS paired with information management strategies to build a more robust supply chain by answering this research question: *What are the effects of networked-SCMS and information management on supply chain* *integration constructs (customer, supplier, and internal integration) to further improve operational performance for manufacturing firms?*

CHAPTER II. LITERATURE REVIEW

Current literature explains the need for a close relationship between manufacturers and their supply chain, and practitioners know the benefits of tight business integration. Ellram & Cooper (2014) point out that since 1982, when Oliver and Weber introduced the concept of Supply Chain Management (SCM), it has been evolving to address the interrelationships and complexities of procurement, operation, and distribution. A contemporary definition of SCM builds upon the network concept (Carter et al., 2015). A dyad does not exchange value in isolation; optimizing value-creation across the supply chain network can generate more economic value than one firm can create (Busse, Meinlschmidt & Foerstl, 2017). Defining multi-enterprise supply chain networks is a premise to move from the dyadic buyer-supplier view of the supply chain into a network of firms exchanging value. Christopher (2016) explains that in the era of network competition, firms organize toward a supply chain goal, forming a community to deliver better service quality, faster response, and delivery at a lower cost to serve their market better and keep a closer relationship with their customers. This strategy improves customer retention and satisfaction. While conceptualizing the supply chain as a network is not new, the implementation of supply chain networks is still under study, and the theory continues to develop (Carter et al., 2015). The Industrial Marketing Journal (2021) acknowledges that supply chain network platforms are understudied and deserve a special issue to advance supply chain theory and contribute to understanding the role of digital technologies in supply chain ecosystems.

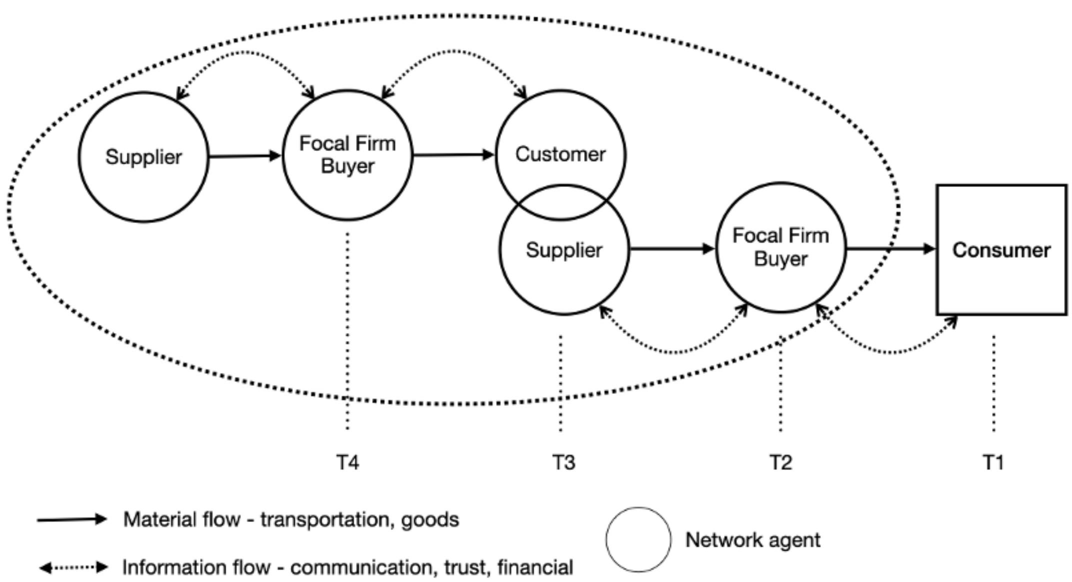
The challenge for firms is in joining and reaping the network's benefits, controlling and managing its upstream and downstream relationships to maximize its gain through differential advantage. The firm in the network must balance and control its operation to increase its performance while interacting with other firms, forming a boundaryless supply chain community (Christopher, 2016). For example, a fashion design firm creates a supply chain community when it contracts capacity to manufacture from a supplier to build a collection (upstream, supplier integration). At the same time, it engages with its customers (downstream, customer integration) to address market demand, and with other firms to provide distribution and transportation. Similarly, the firms that are customers might become suppliers for their downstream customers, until reaching a consumer.

Figure 1 shows a supply chain network conceptualization. The figure uses a longitudinal approach inspired by Christopher's (2016) representation of the extended enterprise and virtual supply chain showing four relevant time milestones from T1 through T4. In T4, a focal firm is central to a community's functioning toward a common goal, acting as a buyer to fulfill the demand posed by its customer in T3. In T2, the cycle repeats but reaches an end fulfilling the consumer request in T1. This figure also shows the diversity of relationships in the supply chain network. First, the pair buyer-supplier represents a dyad (the traditional conceptualization of a supply chain). Second, the relationship buyer-supplier-supplier represents a triadic relationship. The figure shows a triadic relationship between the consumer (buyer), its supplier (the focal firm in T2), and the supplier in T3. Third, it describes how a consumer at the end of the chain pulls multiple resources creating a network relationship.

In contrast to vertical or point-to-point integrations, multi-enterprise supply chain business networks provide flexibility in the relationship of the different firms and their roles at different times, whether acting as buyers or suppliers. Also, Figure 1 displays the two types of flows present in the supply chain: (1) the material flow addressing the physical movement of goods, and (2) the information flow reducing the uncertainty created by the business environment and the need for information processing. Supply chain integration is implicit in conceptualizing supply chain networks and communities. SCI is the glue that makes possible these relationships among firms, promoting sustainable enterprise information systems interoperability and allowing a fluid intra- and inter-organizational dialog by sharing data, process, culture, and knowledge among supply chain partners (Agostinho et al., 2016).

Figure 1

A Supply Chain Network Conceptualization



Organizational Information Processing Theory

The organizational information processing theory (OIPT) (Galbraith, 1974) provides a theoretical lens to study the importance of information flows in the supply chain network and the role of networked-SCMS combined with information management. OIPT's basic proposition is that the greater the uncertainty, the greater the information required to make decisions. In the supply chain network, as described in Figure 1, each firm is a source of uncertainty because it involves exchanging information with the other firms to achieve a business goal. Galbraith (1974) proposes two solutions to deal with uncertainty: (1) reduce the need for information processing by adding slack resources and self-contained tasks, or (2) invest in (vertical) information systems and lateral relations. This paper pursues the second solution by exploring the effects of networked-SCMS and the collaboration between human resources in each firm to achieve efficiencies and reduce slack. For example, each firm in the chain owns part of transforming raw materials into a complete product reaching a consumer (Sundram et al., 2018). Therefore, increasing the amount, accuracy, and timing of information exchanged is central to completing the orchestrated multi-enterprise business flow to achieve the desired supply chain performance level (Galbraith, 1974; Tushman & Nadler, 1978).

Supply Chain Integration

The complexity of inter-organizational relationships, information, material flows, and IT connectivity in the supply chain makes it difficult to create a mental model encompassing and grasping supply chain integration. Flynn, Baofeng, and Xiande (2010) provided a parsimonious definition of the SCI and its dimensions that was widely used in the supply chain integration literature (Busse et al., 2017; Ellram & Cooper, 2014; Errassafi, Abbar & Benabbou, 2019; Srinivasan & Swink, 2015; Sundram et al., 2018). First, supply chain integration represents a firm's efficiency in collaborating with its supply chain partners and collaboratively managing inter-firm and intra-firm processes.

Second, it is not appropriate to study supply chain integration, given its complexity, as a single construct (Flynn et al., 2010).

Since the mid-2000s and with the publication of Flynn et al. (2010), different authors agree that there are three distinct constructs: customer, supplier, and internal integration. Customer and supplier integrations represent the inter-firm efficiencies to collaborate upstream with suppliers and downstream with customers. Our research defines customer integration as the use of common processes and exchange of information to incorporate strategic customer requirements into the focal firm's planning and execution processes, allowing the firm to react to market conditions and changes in demand in order to improve customer satisfaction (Flynn et al., 2010; Srinivasan & Swink, 2015). Our research defines supplier integration as the exchange of strategic information to incorporate demand, production capacity, and inventory for planning, and the use of common procurement processes for execution, toward a common business goal to serve the customer better (Christopher, 2016; Flynn et al., 2010; Srinivasan & Swink, 2015). Internal integration represents the intra-firm efficiencies coordinating the various departments and their employees, such as sales, marketing, production, procurement, and finance. Our research defines internal integration as the organizational practice of using processes and data integration among departments to improve new product development and planning, to fulfill customer requirements and achieve common business goals with suppliers (Christopher, 2016; Flynn et al., 2010).

Supply chain integration dimensions provide a systematic approach for designing orchestrated multi-organizational information flows and processing to maximize the value of the supply chain network platforms. SCI has been evolving; its implementations vary among firms. While some firms have put more effort into internal than external integrations with customers and suppliers, others have focused more on managing their suppliers (Flynn et al., 2010; Srinivasan & Swink, 2015).

Prajogo and Olhager (2012) said that the greater the mutual trust among supply chain partners, the higher the vertical IT customization level to integrate information flows. Helfat and Campo-Rembado (2016) discuss the problems faced by vertically integrated firms with IT customization and how it negatively affects the information system strategy by reducing business agility and operations efficiency. Therefore, information systems and IT strategies need to follow supply chain strategies. For example, firms that pursue a lean supply chain focus on cost reduction, elimination of waste, and incremental improvements for existing products. These firms choose the information systems strategy for efficiency, implementing execution systems such as ERP and warehouse management systems (WMS). Firms that pursue an agile supply chain choose to focus on interfacing closely with the market and providing innovative or customized products. These firms choose an information systems strategy for flexibility, implementing planning systems such as demand and supply planning systems (Qrunfleh & Tarafdar, 2014). While changing information systems strategies is part of the business dynamic; it comes with a high price: each change might require implementing new enterprise application systems with their corresponding supply chain integrations. It leaves an array of disconnected ERPs and SCMS applications that are costly to operate, eroding operational performance.

Networked-SCMS

In the era of network competition, there is a shift from vertical integration – ownership of upstream suppliers and downstream distribution channels – to an extended global supply chain and outsourcing that requires close end-to-end management among firms (Christopher, 2016). The configuration flexibility of supply chain communities brings the challenge of coordinating tasks among firms to achieve a common goal. Each firm executes the assigned tasks with its resources and diverse information systems, technologies, and culture, thus increasing the overall level of uncertainty across the supply chain. To address the uncertainty, firms must invest in networked information systems, increasing their information management and processing capacities to facilitate the information flow and inter-firm communication among managers to resolve conflict (Galbraith, 1974). In the global supply chain organizational configuration, firms remain independent, aiming to maximize their differential advantage to contribute toward a common supply chain goal. However, they most likely have different information systems and management needs. For example, a firm dedicated to providing contract manufacturing has different requirements than firms providing transportation, and firms providing warehousing have even more distinct requirements. When business conditions change, better-prepared firms will adapt their organizations, and information processes must meet the changing requirements (Tushman & Nadler, 1978).

The definition in this paper of networked-SCMS draws from organizational design theories, supply chain and information systems literature, and enterprise software practice. It starts with the evolution of digital society, rethinking the enterprise as a business network operating on a supply chain platform. Networked-SCMS are a new generation of networked best-of-breed enterprise applications. Their design facilitates firms to digitally integrate with their business partners to pursue common objectives by exchanging and managing information and designing multi-enterprise processes using a common formalized decision-making language (Agostinho et al., 2016; Christopher, 2016; Flynn et al., 2010; Galbraith, 1974; Infor, 2021; SAP, 2022a; Titze & McNeill, 2021; Tushman & Nadler, 1978).

The development of networked-SCMS aims to address these constraints in supply chain integration: (1) coordinating orchestrated inter-firm business flows, (2) reducing uncertainty with pre-planned information exchange, and (3) providing flexibility for firms to adapt their business. It allows firms in a multi-enterprise supply chain business network to operate as a hub-and-spoke topology: the focal firm is the central node (hub) connected to other firms (the spokes) to simultaneously (in parallel) manage business exceptions using a standard protocol (Galbraith, 1974). This definition complements the view of Srinivasan & Swink (2015) in conceptualizing SCMS as a vertical information system. However, per its networked-SCMS definition, our research makes an important distinction and departs from the vertical integration view. Its design moves toward the networked integration of best-of-breed enterprise applications to provide a new total solution to solve business network requirements. Planning systems such as demand management and advanced planning systems (APS) and ERPs improve information processing, enabling real-time planning capabilities and providing insights into demand plans, manufacturing plans, production schedules, and available-to-promise (ATP) functions. The scope of networked-SCMS includes planning and integrated execution systems such as transportation management to find the fastest and cheapest route to deliver to customers, systems that provide supply chain visibility, and warehousing management systems that execute intricate picking and distribution operations.

Information Management

Information management provides the rationale and basis for decision-making among people and processes throughout the supply chain network. A highly efficient supply chain relies on an information system (networked-SCMS) to share the relevant information among firms as a fundamental element fostering communication and collaboration (Sundram et al., 2018). Carter et al. (2015) highlight the need for sound information management to reduce uncertainty by providing the example of the 2007 Mattel recall. Even though Mattel had rigorous supplier evaluation, a contract manufacturer bought a contaminated lead-paint coat that went unnoticed. Mattel recalled about one million toys, costing $30 million, additional multimillion-dollar fines, and a 25% drop in stock price. As exemplified by Mattel, the lack of accurate and timely information in the supply chain could lead to economic losses and erosion of the company's reputation, therefore negatively impacting operational performance. At the heart of supply chain management lies the need for a sound supply chain integration strategy leveraging information management to achieve internal and external integration (Busse et al., 2017; Carter et al., 2015). Therefore, we define information management as the strategies used to manage digital information along the multi-enterprise supply chain business network; information management provides internal and inter-organizational rationales, and it provides a basis for decision-making and achieving common planning and execution of business goals (Sundram et al., 2018).

Operational Performance

Defining performance is not straightforward due to supply chain networks' high complexity and interdependencies. It can include operational to financial measures. This paper bases its definition of operational performance on Christopher's (2016) principle that firms organize toward a common business goal to serve their customers. Therefore, operational performance reflects firms' efficiency in customer service and flexibility to better sense and respond to environmental changes, in order to serve their customers (Flynn et al., 2010).

This study focuses on customer service, which is defined as meeting customer expectations. In the supply chain, it means, for example, delivering on time according to the customer order request as agreed in the buyer-supplier procurement process (Flynn et al., 2010). Good customer service improves operational performance, since there is less rework due to implementing acceptable procurement practices and information processing (Srinivasan & Swink, 2015).

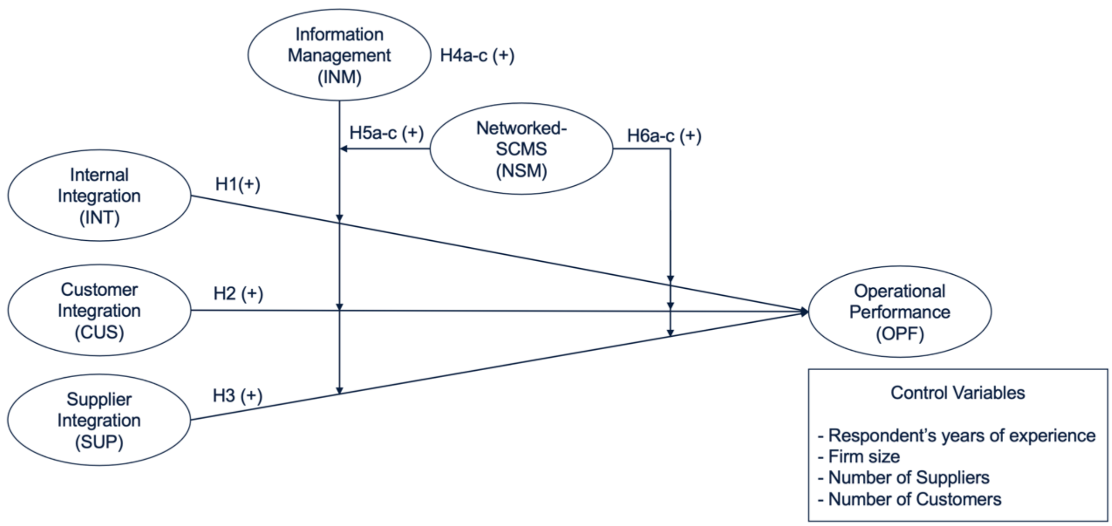
Finally, flexibility relates to how a firm reacts to uncertainty, adapting to fast market conditions such as changing production requirements, short lead times, and supplier selection due to new product offerings. For example, Zara, the Spanish apparel manufacturer and retailer, has a supply chain that continuously monitors customer demand at stores. It matches demand with production and design capacities, displaying a high level of supply chain integration to match external and internal requirements (Qrunfleh & Tarafdar, 2014).

CHAPTER III. RESEARCH MODEL AND HYPOTHESES

Figure 2 shows the proposed research model to explore the moderation effect of information management and networked-SCMS designed to address the needs of firms that join supply chain business networks.

Figure 2

Research Model



Firms adopting information management and networked-SCMS should see (1) a reduction in the time that it takes to negotiate orders with customers and suppliers; (2) improvements to customers' on-time delivery; and (3) a reduction in the levels of uncertainty by increasing information sharing upstream (suppliers' production schedule and capacity) and downstream (customers' demand forecast). Networked-SCMS simplifies a firm's participation in multi-enterprise supply chain business networks, proposing standard information flows and orchestrated processes among networked firms. For example, a buyer creates a purchase order in the supply chain business network; the supplier accesses the order to negotiate quantities and delivery dates. Both buyer and supplier see the same purchase order. They collaborate using an orchestrated process among the firms, improving shipment accuracy, and reducing uncertainty as standard information flows through the supply chain business network. The conventional approach to supply chain integration focuses on using SCMS components such as demand and resource planning, warehouse, and transportation management for execution functions (Srinivasan & Swink, 2015) and not on enterprise integration to reduce costs by aligning information systems and supply chain strategies. This paper builds on the evolution of supply chain integration research that used a contingency approach to establish the relationship between networked-SCMS and supply chain integration (Flynn et al., 2010). The configuration approach identifies the ideal gestalt of networked-SCMS (Liu, Wei, Ke, Wei & Hua, 2016) through the lens of information processing theory (Galbraith, 1974; Tushman & Nadler, 1978).

Networked-SCMS provides firms with a mechanism to fit the information processing requirements with the information processing capacities, matching needs inside and outside the organization (Tushman & Nadler, 1978). Following the example of the purchase order in the supply chain business network, the purchase order provides the required information for the buyer (inside) and the supplier (outside); both parties communicate, satisfying the information requirements. While the orchestrated process provides the required processing capacity between the buyer (inside) and the supplier (outside), both parties use adequate process capacity to complete the task. Hence, there is a fit between information and process requirements.

This research uses Galbraith's (1974) organizational information processing theory lens. It builds upon previous literature on SCI (Busse et al., 2017; Ellram &

Cooper, 2014; Errassafi et al., 2019; Srinivasan & Swink, 2015; Sundram et al., 2018) and adopts OIPT organizational design strategy to increase the capacity to process information, investing in information systems and leveraging lateral relationships to address supply chain integration needs to reduce uncertainty. OIPT distinguishes between information and data. While information generates knowledge, reducing uncertainty among firms in the supply chain business network also requires orchestrated multi-enterprise processes. The sole exchange of data and data processing capabilities does not. Organizations need to adopt an information management strategy that provides flexibility to maximize their operational performance while coping with internal and external sources of uncertainty. Implementing networked-SCMS can help the firms in the supply chain business network achieve these goals (Tushman & Nadler, 1978).

Internal integration

Flynn et al. (2010) propose that internal integration is the basis for SCI. Traditionally, firms have addressed their internal needs to process customer orders, control inventory, organize procurement, perform production planning, implement ERPs, and expand into specialized customer and supplier management. Applying the OIPT view, the ERP facilitates the information processing capacity required to integrate intra-firm supply chain functions such as procurement and production. The ERP provides daily operational control (Qrunfleh & Tarafdar, 2014), using a common language across departments and functional areas to develop collaboration and using lateral relationships to offer higher levels of customer service (Galbraith, 1974). Before the conceptualization of SCI, some authors found no evidence of a direct relationship between internal integration and operational performance. However, Flynn et al. (2010), Alfalla-Luque, Marin-Garcia & Medina-Lopez (2015), and later Errasafi et al. (2019) found a positive direct effect that has been consistent in supply chain integration research. Based on the theoretical foundation of OIPT and findings in the literature, our research proposes the following hypothesis:

> *Hypothesis 1: Internal integration positively impacts operational performance, such as the higher the degree of internal integration that a firm has, the stronger the positive impact on the operational performance of a firm.*

Firms set up integration with their customers and suppliers (1) to coordinate inter-firm activities; (2) to respond faster to changes in the external environment; (3) to implement strategies with suppliers to maintain operational performance, and (4) to find the right fit, matching their information processing capacities with the information processing requirements (Tushman & Nadler, 1978).

Customer integration

Close collaboration with customers increases the accuracy of demand information and positively affects customer satisfaction and product development (Flynn et al., 2010). Customer integration aims to incorporate customer requirements into planning and execution by sharing sales data, forecasts, and inventory levels. This type of integration allows firms to adapt to changes in external conditions and allocate resources accordingly, increasing or decreasing manufacturing capacity as required (Srinivasan & Swink, 2015). Following the OIPT approach of developing information processing capacity, Errassafi et al. (2019) demonstrated that the linkage with customers via information networks and IT reduces decision-making time, which improves customer satisfaction and directly impacts operational performance. In the supply chain, the dyad buyer-supplier relies on the buyer's customer integration to accurately sense and respond to demand, reducing the buyer's inventory levels by leveraging internal collaborative processes that reduce operational costs (Flynn et al., 2010). Continuing the earlier example of Zara, the Spanish apparel manufacturer and retailer, that firm is well known for its rapid design and delivery worldwide. Zara's success highlights the importance of supply chain integration and using supply chain applications to achieve a high degree of flexibility by connecting with customers and suppliers (Qrunfleh & Tarafdar, 2014). Based on the theoretical foundation of OIPT and our findings in the literature (Errassafi et al., 2019; Flynn et al., 2010), our study proposes the following hypothesis:

Hypothesis 2: Customer integration positively impacts operational performance, such as the extent of customer integration intensifies, the stronger the positive impact on the operational performance of a firm.

Supplier integration

Although SCM is about serving the customer, with a focus on being adaptable and flexible to changes in demand, firms also require significant integration with their suppliers to achieve these goals. Supplier integration enables sharing of production capacity and schedules, improving operational performance (Flynn et al., 2010). For example, Walmart has a tight integration with key suppliers such as Procter & Gamble and Black & Decker to improve operational costs. From the OIPT perspective, supplier integration extends the firm's boundaries. Shared information and collaboration help managers detect component variabilities (upstream disruptions); such integration could have prevented the additional financial and operation costs in the Mattel case mentioned earlier (Carter et al., 2015). Supplier integration also permeates changes in customer demand (downstream disruptions).

In addition to information sharing via information systems, lateral relations with suppliers promote better responses to changes in demand and supply (Srinivasan & Swink, 2015). Previous studies have proposed a positive relationship on the impact of supplier integration on operational performance, but their results are ambiguous; while Flynn et al. (2010) did not find statistical significance, Errassafi et al. (2019) did. Based on the theoretical foundation of OIPT and partial findings in the literature, our research proposes the following hypothesis:

Hypothesis 3: Supplier integration positively impacts operational performance, such as the extent of supplier integration intensifies, the stronger the positive impact on the operational performance of a firm.

Moderating Effects of Information Management

Leuschner, Rogers, and Charvet (2013), in their meta-analysis of 86 peer-reviewed articles about SCI and firm performance, determined that information integration has two phases. Phase 1 is coordinating information transfer, communication, and supporting technology. Phase 2, the natural progression, is management's use of the information. This second phase aligns with our research's definition of information management strategies for decision-making processes. Sundram et al. (2018) point out that information management in the supply chain nurtures the implementation of strategies required to make better decisions. When firms align toward a common business goal, these firms require exhaustive analysis of information promoting collaboration and communication between managers to reduce the natural uncertainty originated by a new partnership to introduce new products (Galbraith, 1974; Sundram et al., 2018). Information and its management generate knowledge, reducing uncertainty among firms in the supply chain business network through orchestrated multi-enterprise processes. Simply exchanging data and using data processing capabilities does not have the same effect as information management. Information management provides the rationale and basis to realize the lateral relationships proposed by OIPT. Galbraith (1974) distinguishes four types of relationships: (1) direct contact, (2) liaison roles, (3) task forces, and (4) teams. In each type of relationship, the number of actors grows, making it more relevant as a sound information management strategy. Although not directly discussed in the SCI literature, this research proposes that information management goes beyond exchanging and using information and plays an essential role in the supply chain, strengthening the positive effects of supply chain integration constructs on operational performance. Based on the OIPT theoretical basis and the direct positive effects of information management on performance found by the studies of Leuschner et al. (2013) and Sundram et al. (2018), our study proposes the following hypotheses:

> *Hypotheses 4a-c: Information management positively moderates the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher the level of information management that a firm has, the stronger the positive impact between customer integration (a), internal integration (b), supplier integration (c), and the operational performance of a firm.*

Moderating Effects of Networked-SCMS

Applying the configuration view to networked-SCMS provides a way to understand the multi-dimensional phenomena of supply chain integration. The assumption that organizational elements are interrelated aims to identify the ideal gestalt, instead of analyzing the effects of point solutions. The traditional SCI approach attempts to match IT resources to find the required one-time fit. The path to innovation must evolve from that non-sustainable view. Our theory proposes a new direction — networked-SCMS — that represents a pattern of multi-interdependent organizational elements, IT strategy, and software to enable firms to achieve superior operational performance (Liu et al., 2016; Qrunfleh & Tarafdar, 2014). Firms frequently deal with external and internal work-related and environmental uncertainty in the supply chain business network. For example, as found by practitioners, the procure-to-pay cycle could present at least five significant uncertainty points, increasing the possibility of a reduction in operational performance: (1) Inadequate internal planning capacity exists between sales and procurement due to a lack of sensing market demand. (2) Miscommunication occurs during the ordering process. For example, a buyer is sourcing a particular quantity of a product for a given date. However, the supplier cannot fulfill the order as requested, causing a response that is either slow or inaccurate. (3) After the order is confirmed and goes to production, the factory might face unexpected downtime due to machinery breakdown or labor strikes. (4) Transportation disruptions are also sources of uncertainty; storms and port strikes can affect delivery dates. (5) Buyers might face quality problems by reducing the number of usable products to satisfy customer demand during receiving (Infor, 2021). Building up inventory buffers is a common solution to reduce uncertainty.

However, based on OIPT, the answer is to reduce uncertainty by sharing information and having processing mechanisms to cope with internal and external sources of uncertainty (Galbraith, 1974; Tushman & Nadler, 1978). Our research proposes that firms implementing networked-SCMS should increase shared information levels, reduce uncertainty, and adapt to new conditions while matching new information processing requirements and enhancing information management. Thus, using networked-SCMS will improve operational performance.

Networked-SCMS proposes to address these problems using a common formalized language and information management, thus: (1) coordinating orchestrated inter-firm business flows, (2) reducing uncertainty with pre-planned information exchange, and (3) providing flexibility for firms to adapt their business.

The role of networked-SCMS in this theoretical model has two moderation effects. First, it further strengthens the moderation effects of information management as it provides the basis for an efficient exchange of information for multiparty decision-making in the supply chain business network using standard language and inter-firm processes (Galbraith, 1974). Based on the theoretical foundation of OIPT, our research proposes the following hypotheses:

Hypotheses 5a-c: Networked-SCMS strengthen the positive moderation of information management on the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher use of networked-SCMS strengthens the positive moderation effect of information management in the relationship between customer integration (a), *internal integration (b), supplier integration (c), and the operational performance of a firm.*

Second, there is a direct moderation effect on the relationship between SCI components and operational performance. Flynn et al. (2010) recognized internal integration as a prerequisite for achieving customer and supplier external integrations. Internal integration is where firms invest in IT to match their supply chain and information systems strategies. However, using the configuration approach, uncertainties in external integrations permeate into internal integration, causing communication problems that translate into high operational costs. Even though firms reduce a high degree of internal uncertainty by implementing ERPs, they cannot cope with the problems posed by external inefficiencies that the networked-SCMS proposes to solve. Thus, based on the theoretical foundation of OIPT and findings in the literature (Flynn et al., 2010; Leuschner et al., 2013; Srinivasan & Swink, 2015), our research proposes the following hypotheses:

Hypotheses 6a-c: Networked-SCMS moderates the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher the use of networked-SCMS, the stronger the positive impact between customer integration (a), internal integration (b), supplier integration (c), and the operational performance of a firm.

The following tables summarize the constructs and hypotheses defined in this study.

Table 1

Construct Definitions

Construct	Definition	Supporting Literature
Internal Integration (INT)	The organizational practices that use processes and data integration among departments to improve new product development and planning, to fulfill customer requirements and achieve common business goals with suppliers.	Christopher (2016); Flynn et al. (2010)
Customer Integration (CUS)	The use of common processes and exchange of information to incorporate strategic customer requirements into the focal firm's planning and execution processes, allowing the firm to react to market conditions and changes in demand, to improve customer satisfaction.	Flynn et al. (2010); Srinivasan and Swink (2015)
Supplier Integration (SUP)	The exchange of strategic information to incorporate demand, production capacity, and inventory for planning, using common procurement processes for execution toward a common business goal to better serve the customer.	Christopher (2016); Flynn et al. (2010); Srinivasan and Swink (2015)
Information Management (INM)	Strategies used to manage digital information along the supply chain network, providing internal and inter-organizational rationale and a basis for decision-making, and achieving common planning and execution of business goals.	Sundram et al. (2018)
Networked-SCMS (NSM)	A new generation of networked best-of-breed enterprise applications that help firms digitally integrate with their business partners to pursue common objectives by exchanging information and by designing multi-enterprise processes using a common formalized decision-making language.	Agostinho et al. (2016); Christopher (2016); Flynn et al. (2010); Galbraith (1974); Infor (2021); Titze & McNeill (2021); Tushman & Nadler (1978)
Operational Performance (OPF)	A measure of firms' customer service efficiencies and of their flexibility to sense and respond to environmental changes, to better serve their customers.	Flynn et al. (2010)

Table 2

Hypotheses Summary

#	Hypothesis
H1	Internal integration positively impacts operational performance, such as the higher the degree of internal integration that a firm has, the stronger the positive impact on the operational performance of a firm.
H2	Customer integration positively impacts operational performance, such as the extent of customer integration intensifies, the stronger the positive impact on the operational performance of a firm.
H3	Supplier integration positively impacts operational performance, such as the extent of supplier integration intensifies, the stronger the positive impact on the operational performance of a firm.
H4 a-c	Information management positively moderates the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher the level of information management that a firm has, the stronger the positive impact between customer integration (a), internal integration (b), supplier integration (c), and the operational performance of a firm.
H5 a-c	Networked-SCMS strengthen the positive moderation of information management on the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher use of networked-SCMS strengthens the positive moderation effect of information management in the relationship between customer integration (a), internal integration (b), supplier integration (c), and the operational performance of a firm.
H6 a-c	Networked-SCMS moderates the relationship between customer integration (a), internal integration (b), supplier integration (c), and operational performance. The higher the use of networked-SCMS, the stronger the positive impact between customer integration (a), internal integration (b), supplier integration (c), and the operational performance of a firm.

CHAPTER IV. METHODOLOGY

Method

The research design employs a quantitative method following a consistent approach in the literature reviewed for this study. Although qualitative studies provide essential contributions to theory development, they cannot sample a relatively large population to generalize results in the same way that a quantitative study can. For example, the meta-analysis performed by Leuschner et al. (2013) aggregates quantitative studies published from 1992 through 2011, providing 17,467 observations to comprehensively explain the impact of supply chain integration on firm performance. Therefore, statistical methods in social sciences, such as business research, go beyond analyzing data but help us understand and make sense of a business domain, the relationship and effects of constructs, and test hypotheses (Agresti, 2018).

This research uses questions and valid measures identified in the literature from various sources. Table 1 explains the positive impact of supply chain integration constructs (customer, internal, and supplier integration) on operational performance. The research model further presents the moderating effects of information management and networked-SCMS in the relationship between supply chain integration constructs and operational performance. We use SPSS Statistics, the statistical software analysis tool from IBM, and R Studio, using the lavaan 0.6-12 library for this study to perform descriptive statistics, exploratory and confirmatory factor analysis, and hypotheses testing using multiple regression analysis.

Population of Interest

Our unit of analysis is firms in the manufacturing sector in the U.S. This research studies focal firms because these firms create supply chain communities toward a common business objective. Focal firms must fit the information processing requirements with the information processing capacities, matching needs inside and outside the organization. For example, a brand in the fashion industry creates a community with contract manufacturers and factories to produce a new collection, logistic services to provide transportation, and banks to provide working capital.

Buyer firms as focal firms in the hub-and-spoke topology are the ones in need of reducing uncertainty and, therefore, are the firms with the potential to benefit most from the use of networked-SCMS and information management. Our observation unit is supply chain professionals with the following roles: managers, materials planners, and customer account specialists executing supply chain processes that contribute to downstream activities such as production flexibility, customer services, and operational performance. Our research focuses on these actors (managers and front-line resources in the supply chain network) to make the study operational and avoid problems related to the unit of analysis. Flynn, Pagell & Fugate (2018), in their editorial paper "Survey Research Design in Supply Chain Management," expose numerous difficulties in quantitative research associated with the unit of analysis, the unit of observation, and polyadic constructs. Studies of polyadic constructs, such as supply chain networks, require aggregation in a single composite score to address systematic errors from partial measurements. When the unit of observation is a proxy of the effects in the supply chain, it introduces (respondents') biases such as the halo effect and transient mood, which can produce misleading conclusions. Our research uses monadic constructs to solve these problems; it is focused on a single perspective, surveying respondents closer to the action who reasonably understand the question under the research (Flynn et al., 2018). In summary, the survey requests the participation of supply chain professionals, managers, and individual contributors, with knowledge or working experience in procurement and sales departments.

Sample, MTurk Considerations, Checks, and Common Procedure

After receiving the Institutional Review Board approval, we collected our samples via Amazon Mechanical Turk (MTurk). MTurk is a crowdsourcing service providing survey completion by prescreened and qualified MTurk workers (Paolacci, Chandler & Ipeirotis, 2010). We carefully evaluated the use of the MTurk service, searching the supply chain management literature and finding articles in top-ranked journals (Cheng, Craighead, Crook & Eckerd, 2020; Kaufmann, Schreiner & Reimann, 2022; Ried, Eckerd, Kaufmann & Carter, 2021). These findings provided initial evidence to ease any preconceptions, skepticism, and concerns regarding the MTurk service due to poor data quality questioning the research's validity. Some journals recommended rejecting studies that use data collected via MTurk (Aguinis, Villamor & Ramani, 2021). However, Kaufmann et al. (2022) point out that using MTurk services to conduct research in supply chain management has produced high-quality data and replicability. Like Ried et al. (2021), they recommend following best practices. Aguinis et al. (2021) surveyed fifteen journals, finding 510 empirical papers to support their recommendation of using MTurk. Among their positive findings is that MTurk provides access to a large and diverse participant pool and speeds up data collection at a reasonable price. However, some of their negative findings, such as self-misrepresentation (wrong target population), inattention, and vulnerability to web bots, were of serious concern for our study. To address self-misrepresentation, we followed the recommendation to include screening questions to qualify the participants. We included one question regarding the participant's working experience in business-to-business and three questions regarding their manufacturing and supply chain knowledge, as shown in Appendix A. We also evaluated whether to use attention checks questions (ACQs) or rely on high-reputation workers (approval rating greater than 95%). Peer, Vosgerau & Acquisti (2013) found that high-reputation MTurk workers pay attention to ACQs, and they recommend using high-reputation workers instead of relying on ACQs. We used both methods. We provided a single ACQ at the end of the survey to cross-check years of experience and requested an approval rate greater than 97%. As common procedures, first, we thanked unqualified MTurk Workers and excluded them from continuing to respond to the survey. Second, as a manual data cleansing procedure, we systematically rejected and discarded responses from duplicate IP addresses (to avoid web bots), responses that didn't pass the attention check, and those whose response time was below the half-time predicted by Qualtrics.

We set up the MTurk projects, both pilot and final data collection, to accept responses only from within the U.S. and where the employment industry was equal to manufacturing. The U.S. Bureau of Labor Statistics reports over 12.6 million employees in the manufacturing sector (NAICS 31-33) (*U.S. BUREAU OF LABOR STATISTICS*, n.d.). MTurk workers received a cover letter highlighting the study's objective and their potential contributions to improving supply chain integration. We explained that they would help firms plan their future information system strategies to join supply chain business networks that would connect them with their customers and suppliers.

In the reviewed literature, the response rate was between 6 and 19% ranging from 205 to 617 usable responses with a median of 248. The median number of participants aligns with our a priori sample size of 100 responses for the blind pilot phase and 250 responses for hypotheses testing, satisfying the ideal size to achieve a 95% confidence level according to the “A-priori Sample Size Calculator for Structural Equation Models” (Soper, 2022).

Operationalization

The experimental design is a cross-sectional survey. It uses a 5-point Likert scale from strongly disagree (1) to strongly agree (5) for agreement questions. The perception of use questions uses a 5-point Likert scale ranging from “Not at all” (1) to “To a great extent” (5). Measures are subjective by nature, indicating perception of the causality rather than delivering actual business measures. The survey measures responses from individuals who act as their organizations' proxies to measure performance perceptions. An average aggregate score per factor (construct) mitigates systematic effects, using a mix of answers from different informants and positions in the procurement and sales departments. Working with a 250-respondent sample smooths out unsystematic effects, including contextual factors that can affect respondents’ answers - for example, psychological changes in mood, predilections, and perception of the phenomena.

Control Variables

In addition to the variables of interest, the research includes control variables to limit the influence on the dependent variable in the multiple regression analysis (Agresti, 2018). The job description and respondents' years of experience are used to mitigate the effects of sales and senior manager biases toward longstanding relationships with customers and suppliers. Company size is a frequently used control variable in the literature to avoid the bargaining power of large corporations (Prajogo & Olhager, 2012; Srinivasan & Swink, 2015; Verghese, Koufteros, Schoenherr & Vanpoucke, 2020). Also, the number of customers and suppliers as this study concentrates on the dyad buyer-supplier (sales and procurement) collaboration and not on the number of alliances or customers that might introduce explanatory effects from more advanced firms.

Measures

We adapted existing instruments from past research in the supply chain, measuring the impact of supply chain integration on operational performance (Flynn et al., 2010). For the moderation effects of networked-SCMS and information management, we adapted a scale to measure information technology in the supply chain (Flynn et al., 2010; Prajogo & Olhager, 2012) and information management (Sundram et al., 2018). In preparation for data collection and the first version of the survey, we detected three original doubled-barreled statements (questions or statements that have multiple parts joined by ‘and’), leading the respondent to provide inconclusive responses (Babbie, 2016; Podsakoff, MacKenzie, Lee & Podsakoff, 2003). Therefore, we split the following questions to address each part separately: (1) “The participation level of our major supplier in the process of procurement and production.” (Flynn et al., 2010, p. 69) (2) “We use electronic transfer of purchase orders, invoices, and/or funds.” (3) “We use advanced information systems to track and/or expedite shipments” (Prajogo & Olhager, 2012, p. 518). Then three survey validation procedures took place to ensure the survey's validity before publishing it for final data collection for hypotheses testing. Appendix A shows the measurement instrument organized by construct, factor, and source.

Survey Validation

Although the survey uses existing measures, they are from diverse sources of peer-reviewed research published in academic journals requiring validation. We performed three procedures—an informed pilot, an expert pilot, and a blind pilot—before posting the final instrument for data collection and hypotheses testing.

Informed Pilot

The informed pilot was the first pretest of the instrument, using a panel of three doctoral students trained in survey design and quantitative methodologies, as well as later feedback from a professor. We provided all participants with a copy of the research proposal, including the survey in an appendix, and via Qualtrics to have the same experience as a blind pilot respondent would have. The student panel met to discuss in a virtual room via Zoom and provided valuable initial feedback. In a subsequent meeting with a professor, we reviewed the informed pilot's notes, further improving the survey in the following areas.

(1) Provide clear construct definitions and instructions at the beginning of each section to guide the respondent. This technique reduces the potential common method bias (CMB) effect by introducing methodological separation of the measurements, reducing the salience of previous answers. This separation was necessary since the collection of the predictors and criterion variables are in the same instrument (Podsakoff et al., 2003).

(2) Rephrase the enunciation of the question or statement to repeat the command in the section to keep questions specific and concise, improving the scale (Podsakoff et al., 2003). For example, when the section instructions request the respondent to express their agreement regarding the "extent of," each question starts with "To what extent" to facilitate comprehension and increase response validity.

(3) The original Likert scale from "Not at all" to "Extensive" used by Flynn et al. (2010) for customer, supplier, and internal integrations caused dissonance among the informed panel members. To ensure that the survey will reflect the scale's intention, we reviewed the sources cited by Flynn et al. (2010) because the survey was in Chinese for mainland China and bilingual in Hong Kong. We wanted to discard possible scale problems resulting from multiple translations. Narasimhan & Kim (2002) used a Likert scale from "Extremely Low" to "Extremely High," and Frohlich & Westbrook (2001) used "None" to "Extensive." Since there was no agreement between Flynn et al.'s (2010) sources in the wording of the scales, we consulted the literature searching for "scales examples for surveys." We evaluated several papers, first reading the abstracts and then retaining two articles that served the purpose: "Likert Scales and Data Analysis" by Allen & Seaman (2007) and "Likert Scale Examples for Surveys" by Brown (2010). We used "Not at all" to "To a great extent" for the customer, internal, supplier integrations, and networked supply chain constructs measuring the likelihood of agreement.

In addition, the panel raised concerns regarding the number of questions related to customer integration, supplier integration, and networked SCMS constructs. We proceeded with all the questions during the exploratory and pilot phases of the study because we planned to perform a dimension reduction using factor analysis.

Expert Panel

The second procedure consisted in requesting feedback from eight supply chain management practitioners ranging from managers to CEO co-founders. We emailed the experts an invitation letter with a short description and the research purpose, followed by instructions to answer seven questions—four directly related to the instrument and three associated with the overall experience. The experts had access to a special survey version via Qualtrics software, where they could answer the open questions. Appendix B shows the invitation with the questions and the feedback provided. Six experts provided input; however, we excluded the answers from one expert (EXP4) because the expert provided general feedback, not focusing on the areas of interest. The overall feedback was positive; the experts agreed that the explanations provided context and were helpful. Some experts provided feedback to improve the question or comments to improve some items. We adjusted the questions following the recommendations without losing meaning. Table 3 below shows the original questions and the changes resulting from the feedback in italics. All experts agree that the questions were relevant and that the survey was well organized. Two respondents commented on potential discomfort in answering customer satisfaction questions, but both concluded that it should be fine as the survey asks for perception and no hard evidence. We created a revised version with the feedback from the experts, increasing the instrument's assertiveness and validity (Agresti, 2018). We used this last survey version to perform the blind pilot, the third and final pre-test.

Table 3

Survey Validation - Original and Changed Questions in Italics

Factor	Item
CUS2	To what extent can your organization establish a quick ordering system with your major customers? *To what extent can your organization establish an efficient ordering system with your major customers?*
INT1	To what extent is your organization's data integration level among internal functions? *To what extent is your organization's data integration among internal functions?*
INT2	To what extent is your organization's enterprise application integration level among internal functions? *To what extent is your organization's enterprise application integration among internal functions?*
INT3	To what extent does your organization have an integrative inventory management system? *To what extent does your organization have a centralized inventory management system?*
SUP1	To what extent is the level of participation between your organization and your major suppliers during your design stage? *To what extent is the level of participation between your organization and your major suppliers during your product design stage?*
OPF1	My company can quickly modify products to meet our major customer's requirements. *My company can quickly modify products to meet our major customers' requirements.*

NSM1	To what extent is the level of information exchange between your organization and your major suppliers through information networks? *To what extent is the information exchange between your organization and your major suppliers through information networks?*
NSM2	To what extent is the level of integration among information systems in your network so that each member knows other members' requirements and status? *To what extent is the integration among information systems in your network so that each member knows other members' requirements and status?*
NSM3	To what extent does your organization have electronic collaboration capabilities with your major suppliers through information networks? *To what extent does your organization perform inter-organizational coordination with your major suppliers through information networks?*
INM3	My organization achieves inter-organizational coordination using electronic links. *My organization achieves inter-organizational coordination using information networks.*
INM4	My organization practices quick information flows along the supply chain. *My organization practices efficient information flows along the supply chain*.

Blind Pilot

The third validation study, the blind pilot, consisted of collecting through Amazon MTurk the responses of at least one hundred (100) qualified professionals working in the manufacturing industry. The respondents included managers and individual contributors with experience in sales, customer service, planning, or procurement departments at B2B (business-to-business) manufacturing companies. Data collection occurred from August 18, 2022, through August 24, 2022. We obtained an initial sample of 321 responses, and 103 were qualified for data analysis (32.08% usability). We analyzed outliers. Three cases were identified after analyzing outliers using the interquartile range (IQR) criteria of 1.5(IRQ) below and above the lower and upper quartile correspondingly (Agresti, 2018). However, we decided to retain them as legitimate cases as they were not outliers for all our factors (Osborne & Overbay, 2004). The final sample, then, consisted of 103 responses. Regarding the sample size, MacCallum, Widaman, Zhang & Hong (1999) indicate that there is a common misconception expecting that the sample size should be invariant among studies. When there is a good number of items per latent factor (five or more), and the items are closely related to the factor, a sample of 100-200 could be adequate (Matsunaga, 2010). Such was the case in our proposed survey, with a minimum of five and a maximum of twelve items per latent factor.

Common Method Bias

Following Podsakoff et al. (2003) recommendations, we assessed common method bias using a single-common-method-factor approach since the study uses a single respondent, and we couldn't identify a potential source of method bias. We assessed CMB in two instances: pre- and post-dimension reduction.

Before starting any procedure, we tested our variables' normality to select the most appropriate extraction method for the factor analysis. The Kolmogorov-Smirnov and Shapiro-Wilk tests provided evidence that the data was not normally distributed, violating the assumption of multivariate normality. Therefore, we chose the principal axis factoring (PAF) extraction method following Costello & Osborne's (2005) recommendation. We then ran a factor analysis using the PAF method with Eigenvalues greater than one. Thirteen factors explained 71.88% of the cumulative variance extracted. The first factor explained 32.04%, which is not the majority of the variance, presenting initial evidence of no significant presence of common method bias. Furthermore, these percentages of variance explained are comparable with the ones obtained by Flynn et al. (2010) and deemed acceptable for a supply chain study where the constructs are practically and theoretically correlated.

Sample Size

We reviewed the adequacy of the sample size by investigating the items' communalities (the variance extracted from the variable accounted for the common factor). The results show that most were greater or equal to .5 and a mean level of .62 (.7 is ideal), supporting our sample size adequacy (MacCallum et al., 1999). The Kaiser-Meyer-Olkin (KMO) test was slightly greater than .80 (meritorious), according to Kaiser & Rice (1974), providing additional evidence that the sample size was adequate.

Factor Analysis

We performed dimension reduction using exploratory factor analysis (EFA), followed by testing the reliability and validity of the data collection instrument for hypotheses testing. We again used the PAF method of extraction with Eigenvalues greater than one. We selected the Direct Oblimin rotation. We chose an oblique rotation because it allows the factors to be correlated (Costello & Osborne, 2005), as is in our case in the supply chain (Flynn et al., 2010). We also suppressed loadings with an absolute value below.4. We inspected the results. First, we verified that there is no evidence of multicollinearity using the heuristic that the determinant of the correlation matrix (2.435E-15) should be greater than 0.00001.

We then inspected the pattern matrix, which showed the thirteen factors without cross-loading and items without loadings. We then ran EFA constrained to extract six factors. The pattern matrix showed that one item had cross-loadings, and several had no loadings. However, the items had mixed loadings, presenting an important finding for our research that uses pre-existing instruments to measure the constructs because exploratory factor analyses are difficult to replicate. Replicability is possible with a large sample size or robust data (Costello & Osborne, 2005). It is important to consider that supply chain practice and theory continue to develop (Flynn, Pagell & Fugate, 2020), and the respondents' perceptions, priorities, and points of view might have potentially changed, impacting the replicability based on preexisting instruments. In the discussion chapter, we will expand on the changes in this relatively new research field and the suggestions for further research. Therefore, we proceeded to perform dimension reduction for the constructs deemed to have a large number of items individually (more than six). We removed two items for customer integration because they were loading in a different factor. These items measured relational communications in the dyad between buyer-supplier and not the exchange of information toward a common goal. Then we analyzed supplier integration; all items were loaded in a single factor. We decided to retain the first six items with stronger loading. The retained items also pertain to the exchange of information. We finally proceeded with the items for the networked SCMS construct. The pattern matrix showed item cross-loadings, items in a separate factor, and items with loading below .4. We retained the strongest items loading in the first factor clustering on the exchange of information through the information network. We discarded the items in italics in Appendix A from the survey for hypotheses testing.

Using the retained items, we performed the second common method bias assessment, scale reliability, and convergent and discriminant validity. For the second

CMB, we performed a confirmatory factor analysis of Harman's single factor model, obtaining the following fit indices: $X^2(560) = 995.439$, RMSEA = 0.087, SRMR = 0.089, CFI = 0.704, NNFI = 0.685. The model was unacceptable and worse than the measurement model $X^2(545) = 870.155$, RMSEA = 0.076, SRMR = 0.084, CFI = 0.779, NNFI = 0.759. The values obtained from the factor analysis and the confirmatory factor analysis suggest no significant presence of common method bias. We then calculated scale reliability. The alpha values ranged from .618 to .855, as shown in Table 4. Two items were below the acceptable range of 0.70 to 0.95 (Tavakol & Dennick, 2011); however, they were not in the unacceptable range below .5 (Gliem & Gliem, 2003). We assessed convergent validity (the extent of correlation among measures of the same construct), using the average variance extracted (AVE) criterion where values of 0.50 and above indicate that the constructs explain more than half of the indicators' variance, therefore displaying convergence validity. As shown in Table 4, operational performance and information management show borderline values (Hair, Hult, Ringle & Sarstedt, 2017).

We then assessed discriminant validity (the extent to which a construct is distinct from other constructs measured in the model), using the heterotrait-monotrait ratio (HTMT) of the correlations criterion, where conceptually similar constructs (for example, customer and supplier integration in this study) are practically and theoretically highly correlated (Flynn et al., 2010). Therefore, we used the criteria of HTMT that values above .90 suggest a lack of discriminant validity (Hair et al., 2017). Table 5 presents the HTMT values. All constructs, except for customer and supplier integration, show discriminant validity. We decided to proceed with the current survey design based on our literature review.

Table 4

Correlations, Descriptive Statistics, and Cronbach's Alpha

Correlations							
	INT	CUS	SUP	OPF	NSM	IMN	Alpha
INT	**0.548**						0.726
CUS	.609**	**0.609**					0.774
SUP	.631**	.784**	**0.706**				0.853
OPF	.387**	.417**	.297**	**0.472**			0.638
NSM	.575**	.683**	.748**	.397**	**0.703**		0.855
INM	.588**	.471**	.553**	.540**	.627**	**0.495**	0.618
Mean	3.977	3.930	3.896	4.107	3.990	4.115	
Std. Dev.	0.504	0.544	0.632	0.437	0.600	0.446	

N = 103

** Correlation is significant at the 0.01 level (2-tailed).

The diagonal shows the squared root of AVE

Table 5

Heterotrait-Monotrait Ratio (HTMT) of the Correlations

	INT	CUS	SUP	OPF	NSM	IMN
INT	1.000					
CUS	0.757	1.000				
SUP	0.764	0.970	1.000			
OPF	0.495	0.567	0.399	1.000		
NSM	0.621	0.842	0.868	0.512	1.000	
INM	0.816	0.656	0.772	0.868	0.862	1.000

CHAPTER V. MAIN STUDY RESULTS

Final Sample

We set up an Amazon MTurk project to collect responses from 250 qualified manufacturing and supply chain professionals. Data collection occurred from January 24, 2023, through February 1, 2023. We obtained an initial sample of 438 responses. After performing data cleansing procedures, 142 qualified for data analysis. We analyzed outliers, but we did not identify any using the IQR criteria (Agresti, 2018). The sample, then, consisted of 142 responses. We cannot report the response rate since we were setting a target in MTurk, but the usability ratio of the responses was 32.42%, following the same trend as the data collected for the blind pilot. We merged the two samples to work with a larger sample closer to our a priori sample size calculation and the literature reviewed. We performed Levene's test for equality of variance to test the homogeneity of the independent samples. The results in Table 6 show the group statistics, and Table 7 shows that the samples are homogenous. We merged the samples, since each variable in both samples is not significantly different. Levene's test null hypothesis assumes equal variances. Therefore, based on the results obtained, we couldn't reject it. The final sample consisted of 245 responses. Table 8 below shows the correlations and descriptive statistics of the final sample used to test hypotheses.

Table 6

Group Statistics

	Sample	N	Mean	Std. Dev.	Std. Error Mean
Internal Integration	1	103	3.977	0.504	0.050
	2	142	3.965	0.494	0.041
Customer Integration	1	103	3.930	0.544	0.054
	2	142	4.015	0.421	0.035
Supplier Integration	1	103	3.896	0.632	0.062
	2	142	3.918	0.476	0.040
Operational Performance	1	103	4.107	0.437	0.043
	2	142	4.094	0.454	0.038
Networked SCMS	1	103	3.990	0.600	0.059
	2	142	4.018	0.466	0.039
Information Management	1	103	4.115	0.446	0.044
	2	142	4.128	0.475	0.040

Table 7

Independent Sample Test

Independent Samples Test

		Levenes Test for Equality of Variance				Significance	
		F	Sig.	t	df	One-Sided p	Two-Sided p
Internal Integration	E.V.A.	0.031	0.861	0.195	243.000	0.423	0.846
	E.V not A.			0.194	217.436	0.423	0.846
Customer Integration	E.V.A.	2.859	0.092	-1.376	243.000	0.085	0.170
	E.V not A.			-1.322	184.499	0.094	0.188
Supplier Integration	E.V.A.	1.561	0.213	-0.302	243.000	0.381	0.763
	E.V not A.			-0.289	181.020	0.386	0.773
Operational Performance	E.V.A.	0.616	0.433	0.223	243.000	0.412	0.824
	E.V not A.			0.224	224.515	0.411	0.823
Networked SCMS	E.V.A.	1.347	0.247	-0.401	243.000	0.344	0.689
	E.V not A.			-0.385	185.105	0.350	0.700
Information Management	E.V.A.	2.570	0.110	-0.227	243.000	0.410	0.821
	E.V not A.			-0.229	227.447	0.409	0.819

Table 8

Final Sample, Correlations, and Descriptive Statistics

Correlations	INT	CUS	SUP	OPF	NSM	IMN
INT	**0.555**					
CUS	.656**	**0.557**				
SUP	.714**	.752**	**0.628**			
OPF	.613**	.547**	.518**	**0.512**		
NSM	.704**	.711**	.763**	.574**	**0.624**	
INM	.694**	.573**	.618**	.724**	.703**	**0.547**
Mean	3.970	3.979	3.908	4.099	4.006	4.122
Std. Dev.	0.497	0.477	0.545	0.445	0.525	0.462

N = 245

** Correlation is significant at the 0.01 level (2-tailed).

The diagonal shows the squared root of AVE

Respondent Characteristics

Table 9 shows the summary of respondents' characteristics.

Table 9

Summary of Respondents' Characteristics

Job Description	N	%
Sales Manager	155	63.30%
Procurement Manager	48	19.60%
Materials Planner	22	9.00%
Cust. Acct. Specialist	12	4.90%
Other	8	3.30%

Industry	N	%
Industrial Manufacturing	220	89.80%
Industrial Machinery	7	2.90%
Automotive	6	2.40%
Oil and Gas	6	2.40%
Chemicals	4	1.60%
Life Sciences	2	0.80%

Company Size (# of employees)		
	N	%
50-999	149	60.80%
1,000-4,999	65	26.50%
> 5,000	29	11.80%
1-49	2	0.80%

Years of Experience		
Average		7.93
Std. Deviation		5.932
Min.		2
Max		33
3-6	146	59.59%

# Customers (80% Sales)		
	N	%
26-50	96	39.20%
51-100	89	36.30%
1-25	33	13.50%
>100	27	11.00%

# Suppliers (80% Procurement)		
	N	%
11-15	62	25.30%
16-20	50	20.40%
6-10	48	19.60%
21-25	46	18.80%
>25	33	13.50%
1-5	6	2.40%

The majority of the respondents 63.30% (or 155) self-identify as Sales Managers, with 19.60% (48) as Procurement Managers, 9.00% (22) as Material Planners, 4.90% (12) as Customer Account Specialists, and 3.30% as other positions. The average years of experience were 7.93, with the majority of the respondents, 59.59% (146), having between 3-6 years. 89.80% (220) work in Industrial Manufacturing. Regarding company size measured by the number of employees, the majority of the respondents, 60.80% (149), reported between 50-999, followed by 26.50% (65) between 1000-4999 employees. Regarding the number of customers representing 80% of their sales, the majority, 39.20% (96), reported between 26-50, followed by 36.30% (89) between 51-100 customers. Finally, the number of suppliers representing 80% of their procurement, the majority, 25.30% (62), reported between 11-15, followed by 20.40% (50) between 16-20 suppliers.

Model Fit and Its Explanatory Power

Before testing the hypotheses, we assessed the model's fit using confirmatory factor analysis and multiple regression analysis. The fit indices obtained are not conclusive: $X^2(545) = 1116.256$ (p = 0.000), RMSEA = 0.065, SRMR = 0.062, CFI = 0.818, TLI = 0.801. The large value of the Chi-square (X^2) goodness of fitness indicates a poor fit. However, X^2 is not the only fit index reported because it is sensitive to the sample size. The root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), the comparative fit index (CFI), and the Tucker-Lewis index (TLI) are fit indices that, when reported together, provide a better model fit explanation (Brown & Moore, 2012). Hu & Bentler (1999) provides cutoff criteria for fit indexes and warns that with small samples $N \leq 250$, the combinational fit rules could result in rejecting valid models under non-robustness conditions. Table 10 below compares the results obtained with the cutoff guidelines. Using the RMSEA and SRMR combination with values greater than .06, according to Hu & Bentler (1999), provides a close to acceptable model fit.

Table 10

Model Fit - Confirmatory Factor Analysis and Cutoff Guidelines

Model Indices	Results	Hu & Bentler (1999) criteria
X^2/df	$X^2(545) = 1116.256$ (p = 0.000)	p-value > 0.001
RMSEA	0.065	close to 0.06
SRMR	0.062	close to 0.08
CFI	0.818	close to 0.95
TLI	0.801	close to 0.95

We set up the multiple regression model to assess the model's power and evaluate the presence of homoscedasticity. Table 11 presents the model summary and its explanatory power.

Table 11

Model Explanatory Power

Model	R Square	Change Statistics		
		R Square Change	F Change	Sig. F Change
1	0.109	0.109	5.835***	<.001
2	0.572	0.464	50.76***	<.001
3	0.606	0.033	6.52***	<.001
4	0.683	0.077	18.468***	<.001
5	0.719	0.036	9.743***	<.001

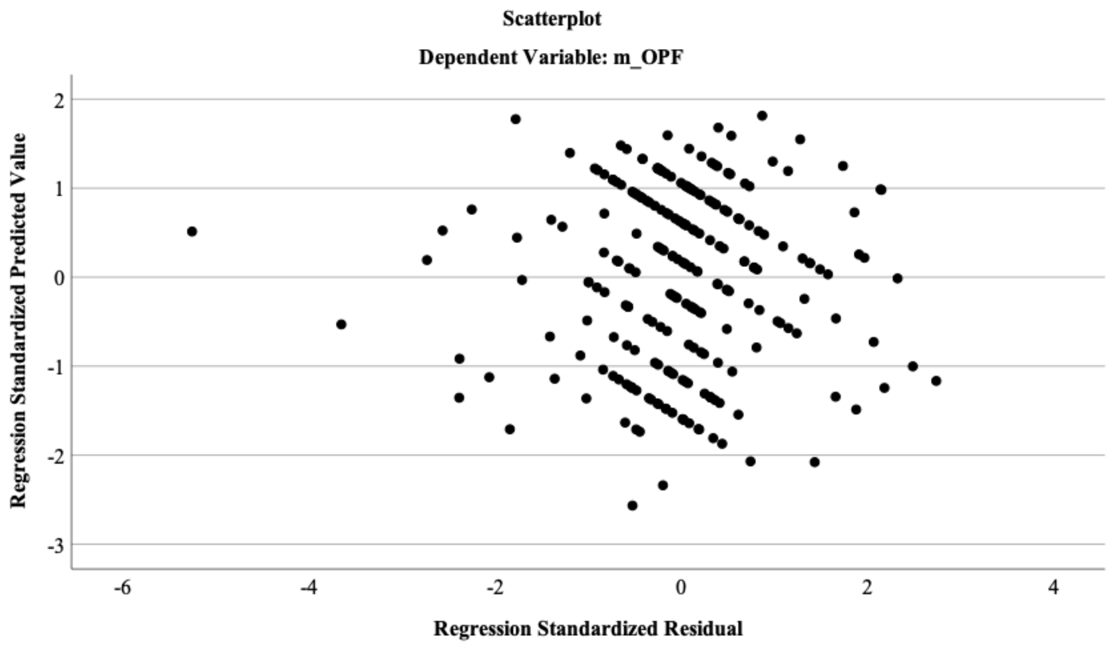
1. Predictors: (Constant), Job Description, Years of Experience, Company Size, # Customers, # Suppliers (Control Variables)
2. Predictors: (Constant), (Control Variables), Internal Integration, Customer Integration, Supplier Integration, Information Management, Networked-SCMS (Independent Variables)
3. Predictors: (Constant), (Control Variables), (Independent Variables), Information Management x Internal Integration, Information Management x Customer Integration, Information Management x Supplier Integration (Information Management Moderation)
4. Predictors: (Constant), (Control Variables), (Independent Variables), (Information Management Moderation), Information Management x Networked-SCMS x Internal Integration, Information Management x Networked-SCMS x Customer Integration, Information Management x Networked-SCMS x Supplier Integration (Information Management x Networked-SCMS 3-Way Moderation)
5. Predictors: (Constant), (Constant), (Control Variables), (Independent Variables), (Information Management Moderation), (Information Management x Networked-SCMS 3-Way Moderation), Networked-SCMS x Internal Integration, Networked-SCMS x Customer Integration, Networked SCMS x Supplier Integration

Dependent Variable: Operational Performance
*p<0.1; **p<0.05; ***p<0.001

For the interaction terms (two-way and three-way), we mean-centered internal, customer, and supplier integration, information management, and networked-SCMS to reduce nonessential multicollinearity interference in interaction terms and make the results easy to interpret (Agresti, 2018; Iacobucci, Schneider, Popovich & Bakamitsos, 2016). We introduced the variables in the following order. First, in Block 1, we entered the control variables (Job Description, Years of Experience, Company Size, # Customers, and # Suppliers). Then we entered the mean-centered independent variables in Block 2. We entered the interaction terms for the information management moderator on the independent variables in Block 3. Then we entered three-way interaction terms between networked-SCMS and information management in Block 4. Finally, we entered the interaction terms for the networked-SCMS moderator on the independent variable in Block 5. The results showed that each model in the multiple regression was statistically significant, indicating that the overall model improved when we introduced the moderators, increasing the predicted power ($R^2 = .719$). The scatterplot of the standardized predicted values against the standardized residuals, shown in Figure 3 below, presented a random distribution. It provided support for a linear relationship and no violation of the assumption of homoscedasticity.

Figure 3

Scatterplot of the standardized predictive value and residuals



Hypotheses Testing

We used linear regression analysis to test the direct effects of the independent variables internal integration (H1), customer integration (H2), and supplier integration (H3) on operational performance, the dependent variable. We also used linear regression to test the moderation effects of information management (H4a-c) on the independent and dependent variables and the moderation effects of networked-SCMS (H6a-c) on the relationship between the independent variables and the dependent variable. To test the three-way moderation effects of networked-SCMS on the information management moderations (H5a-c), we used Hayes's Model 3 plug-in for SPSS. For the interaction terms (two-way and three-way), we used the mean-centered variables internal integration, customer integration, supplier integration, information management, and networked-SCMS.

The following tables summarize the results obtained in the test of the hypotheses. Table 12 shows a summary of the results and the variance inflation factor (VIF) values. All VIF values were well below the cutoff range of 5-10 (Craney & Surles, 2002), indicating no presence of multicollinearity. Table 13 shows the results of the three-way moderation.

Table 12

Hypotheses Testing Results

Hypothesis		Beta	t	Sig.	VIF	Results
H1	Int.[a] → Oper. Perf.[a]	.577	11.378***	<.001	1.059	Supported
H2	Cust.[a] → Oper. Perf.	.520	9.785***	<.001	1.058	Supported
H3	Sup.[a] → Oper. Perf.	.531	9.697***	<.001	1.117	Supported
H4a	Inf. Mgm.[a] x Int→ Oper. Perf.	.120	2.687**	.008	1.108	Supported
H4b	Inf. Mgm. x Cust. → Oper. Perf.	.171	3.977***	<.001	1.070	Supported
H4c	Inf. Mgm. x Sup. → Oper. Perf.	.184	4.097***	<.001	1.124	Supported
H5a	Net-SCMS[a] x Inf. Mgm.x Int.[b] → Oper. Perf.	.179	1.636*	.103	n.a.	Supported
H5b	Net-SCMS x Inf. Mgm. x Cust.[b] → Oper. Perf.	.172	2.009**	.045	n.a.	Supported
H5c	Net-SCMS x Inf. Mgm. x Sup.[b] → Oper. Perf.	.073	.883	.378	n.a.	Not Supported
H6a	Net-SCMS x Int. → Oper. Perf.	.262	5.460***	<.001	1.132	Supported
H6b	Net-SCMS x Cust. → Oper. Perf.	.269	5.257***	<.001	1.191	Supported
H6c	Net-SCMS x Sup. → Oper. Perf.	.309	5.828***	<.001	1.284	Supported

a. Int. = Internal Integration; Cust. = Customer Integration; Sup. = Supplier Integration; Inf. Mgm = Information Management; Net-SCMS = Networked-SCMS; Oper. Perf. = Operational Performance

b. +1SD Conditional Results (Hayes Model 3)

*p<0.1; **p<0.05; ***p<0.001

Table 13

Three-way Moderation - Main and Conditional Effects Results

Main effects			Beta/Effect	t	Sig.
Net-SCMS x Inf. Mgm. x Int.a → Oper. Perf.			-.322	-2.019**	.045
Net-SCMS x Inf. Mgm. x Cust. → Oper. Perf.			-.318	-2.950**	.003
Net-SCMS x Inf. Mgm. * Sup. → Oper. Perf.			-.209	-.817	.415
Conditional Effects	Inf. Mgm.	Net-SCMS	Beta/Effect	t	Sig.
Net-SCMS x Inf. Mgm. x Int. → Oper. Perf.					
-1SD	-.462	-.525	.165	1.496	.136
Mean	.000	.000	.250	4.079***	.000
+1SD	.462	.525	.179	1.636*	.103
Net-SCMS x Inf. Mgm. x Cust. → Oper. Perf.					
-1SD	-.462	-.525	.158	1.097	.274
Mean	.000	.000	.242	3.180**	.002
+1SD	.462	.525	.172	2.009**	.046
Net-SCMS x Inf. Mgm. x Sup. → Oper. Perf.					
-1SD	-.462	-.525	.284*	1.970*	.050
Mean	.000	.000	.229**	2.801**	.006
+1SD	.462	.525	.073	.883	.378

a. Int. = Internal Integration; Cust. = Customer Integration; Sup. = Supplier Integration; Inf. Mgm = Information Management; Net-SCMS = Networked-SCMS; Oper. Perf. = Operational Performance

*p<0.1; **p<0.05; ***p<0.001

Procedure and Results

As standard procedure, we always reset the linear regression panel and introduced the variables. First, we entered operational performance as the dependent variable. Then, in Block 1, we entered the control variables (Job Description, Years of Experience, Company Size, # Customers, and # Suppliers). We held the variables in Block 1 for the following regression tests. We will not report it in each hypothesis test procedure, for brevity.

We tested the direct effects of internal integration (INT) on operational performance (OPF). We entered the INT in Block 2 and ran the regression analysis. We proposed in H1 that there is a positive effect between INT and OPF; that is, the higher the degree of INT (internal integration), the stronger the positive impact on OPF (operational performance), and this hypothesis is supported ($\beta = .577$, $p < .001$). Then we tested the direct effect of customer integration (CUS) on OPF. In Block 2, we entered CUS and ran the regression. H2 proposes that there is a positive effect between CUS and OPF; that is, the greater the extent of integration of CUS (customer integration) intensifies, the stronger the positive impact on OPF, and this hypothesis is supported ($\beta = .520$, $p < .001$). To test the direct effect of supplier integration (SUP) on OPF, we entered SUP in Block 2 and ran the regression. The results show that H3 was also supported ($\beta = .531$, $p < .001$). H3 proposed that the extent of SUP (supplier integration) intensifies, the stronger the positive impact on OPF.

Then we tested the moderation effects of information management (INM) on the relationship between INT, CUS, SUP, and OPF (hypotheses H4a-c). We entered the mean-centered variables for IMN and INT in Block 2 and the interaction term between information management and internal integration (INM x INT) in Block 3; then we ran the regression. The results showed that H4a was significant (β = .120, p = .008), supporting our hypothesis that INM positively moderates the relationship between INT and OPF; that is, the higher the level of INM (information management), the stronger the positive impact on OPF. We tested H4b, entering the mean-centered variables for IMN and CUS in Block 2 and the interaction term between information management and customer integration (INM x CUS) in Block 3; then we ran the regression. The results showed that H4b was significant (β = .171, p < .001), supporting our hypothesis that INM (information management) positively moderates the relationship between CUS and OPF; that is, the higher level of INM (information management), the stronger the positive impact on OPF. To complete the test for the moderation effects of INM, we tested H4c. We entered the mean-centered variables for IMN and SUP in Block 2 and the interaction term between information management and supplier integration (INM x SUP) in Block 3; then we ran the regression. The results showed that H4c was also significant (β = .184, p < .001), supporting our hypothesis that INM positively moderates the relationship between SUP and OPF; that is, the higher the level of INM, the stronger the positive impact on OPF. Panels A through C in Figure 4 below display the interaction plots of each moderation at different levels, showing the intersection and indicating a moderation effect.

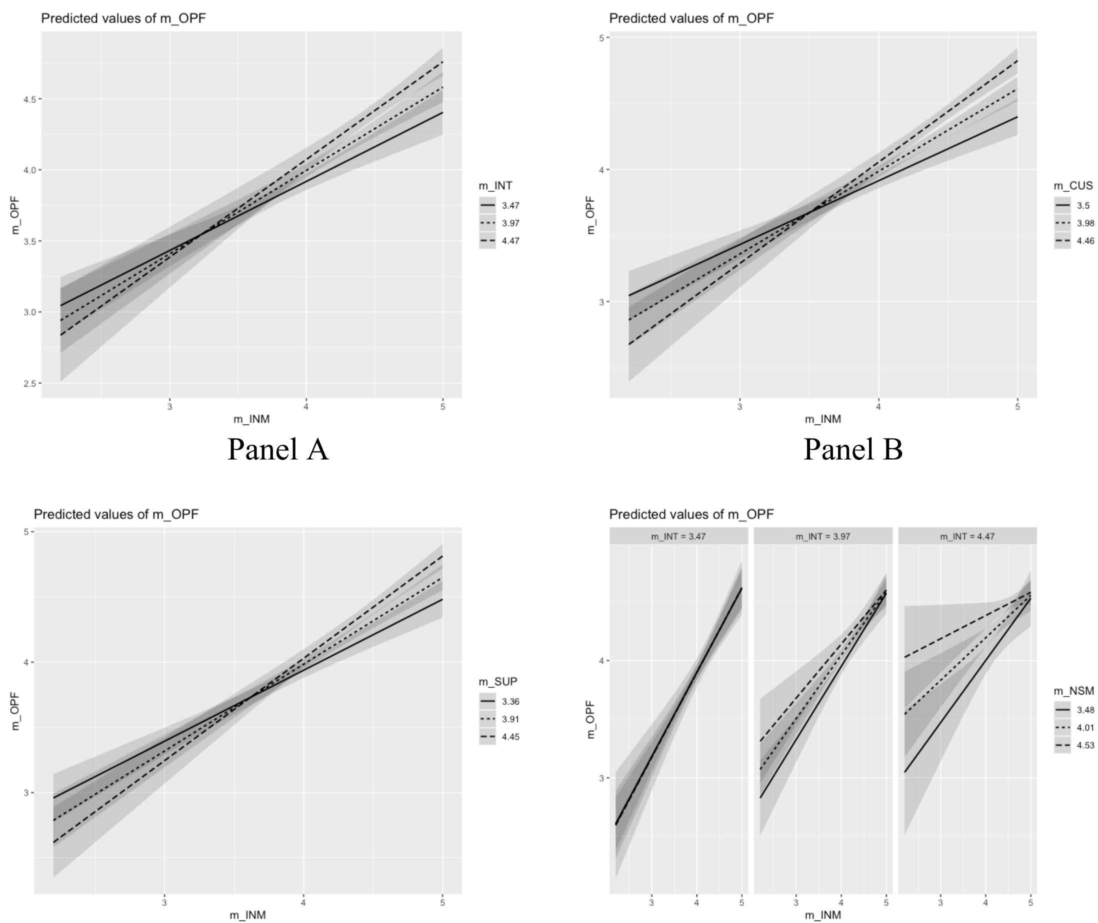
For the three-way moderation interaction, we tested each interaction, setting up the X variable, first for internal integration (INT), then for customer integration (CUS), and finally for supplier integration (SUP). We set the Y variable to operational performance (OPF), we set the moderator variable W to information management (INM), and the moderator variable Z to networked-SCMS (NSM). We also set the following options: (1) mean centering all variables defined in products and (2) showing all moderation conditioning values at -1SD, Mean, and +1SD. H5a-c proposes that networked-SCMS (NSM) strengthens the positive moderation effect between INM and INT, CUS, and SUP; that is, the higher greater the use of NSM (networked-SCMS), the stronger the positive moderation effect of INM (information management) in the relationship between the independent variables (INT, CUS, SUP) and the dependent variable (OPF). Although the hypotheses were statistically significant for the three-way interactions between information management, networked-SCMS, and internal integration (INM x NSM x INT), and between information management, networked-SCMS, and customer integration (INM x NSM x CUS), the beta coefficient of all interactions showed a negative slope, indicating that networked-SCMS (NSM) weakens the moderation effects of information management (INM). We found these results confounding. The Yule-Simpson's Paradox (YSP) helped us explain the phenomenon: where statistically independent attributes are grouped, as in our model, "the direction of the association is determined by whether the related attributes are greater or less than the value placed on the attribute when it is independent" (Goltz & Smith, 2010, p. 2). To analyze the effects at different levels of information management (INM) and networked-SCMS (NSM), we looked into the conditional effects at -1SD, mean, and +1SD of Haye's model 3 results, as our hypotheses theorized a positive moderation effect at higher values (+1SD) of information management (INM) and networked-SCMS (NSM). We found that H5a, the integration between information management and networked-SCMS and internal integration (INM x NSM x INT), was supported at the more conservative 0.1

level (β = .179, p = .103); H5b, the interaction between information management and networked-SCMS and customer integration (INM x NSM x CUS) was significant (β = .172, p = .045); and H5c, the interaction between information management, networked-SCMS and supplier integration (INM x NSM x SUP), was not supported (β = .731, p = .378). Table 13 above shows the main results and conditional effects of extreme values. Panels D and E in Figure 4 below plot the interactions of each three-way moderation at different levels, showing the intersection and indicating a moderation effect. In contrast, Panel F shows no moderation effect.

Finally, in the interest of H6a-c, we tested the moderation effects of networked-SCMS (NSM) on the relationship between INT, CUS, SUP, and OPF. We entered the mean-centered variables for NSM and INT in Block 2 and the interaction term between networked-SCMS and internal integration (NSM x INT) in Block 3; then we ran the regression. The results showed that the test for H6a was significant (β = .262, $p < .001$), supporting our hypothesis that NSM positively moderates the relationship between INT and OPF; that is, the greater the use of NSM (networked-SCMS), the stronger the positive impact on OPF. Then we tested H6b. We entered the mean-centered variables for NSM and CUS in Block 2 and the interaction term between networked-SCMS and customer integration (NSM x CUS) in Block 3; then we ran the regression. The results showed that the test for H6b was significant (β = .269, $p < .001$), supporting our hypothesis that NSM positively moderates the relationship between CUS and OPF; that is, the greater the use of NSM (networked-SCMS), the stronger the positive impact on OPF. To complete the test for the moderation effects of NSM, we tested H6c. We entered the mean-centered variables for NSM and SUP in Block 2 and the interaction term between networked-SCMS and supplier integration (NSM x SUP) in Block 3; then we ran the regression. The results showed that H6c was also significant (β = .309, p < .001), supporting our hypothesis that NSM positively moderates the relationship between SUP and OPF; that is, the greater the use of NSM (networked-SCMS), the stronger the positive impact on OPF. Panels G through I in Figure 4 below plot the interactions of each moderation at different levels, showing the intersection and indicating a moderation effect.

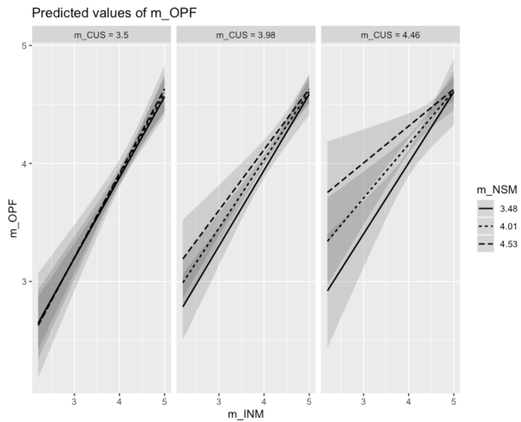
Figure 4

Interactions Plots

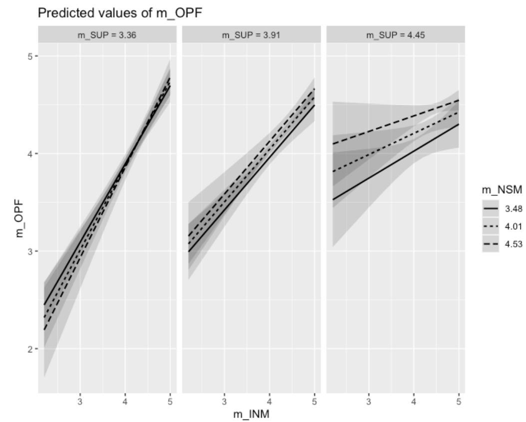


Panel A Panel B

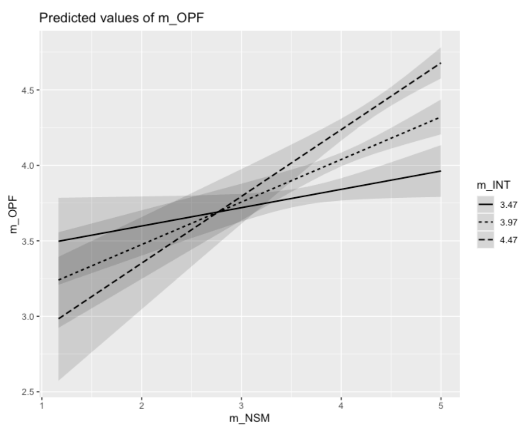
Panel C Panel D



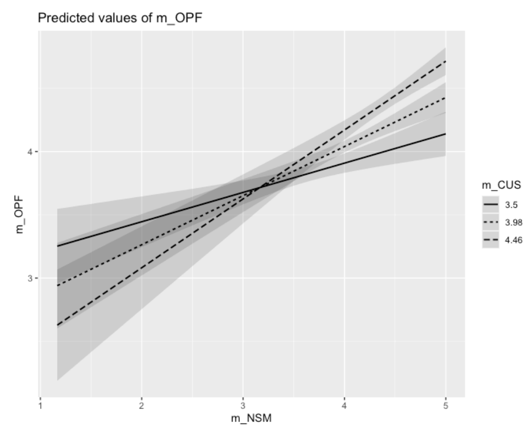
Panel E



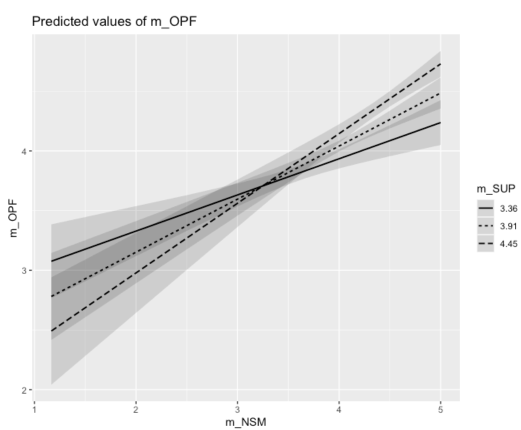
Panel F



Panel G



Panel H



Panel I

In the following sections, we will discuss the results' limitations and implications.

CHAPTER VI. LIMITATIONS

Before starting the discussion chapter, as with any research, we want to acknowledge several limitations of our study. Although we have taken into account and minimized by design the difficulties in quantitative analysis in the supply chain management field (Flynn et al., 2018), we need to acknowledge and highlight the possibility of the following limitations.

First, supply chain networks are complex and constantly changing. While supply chain members are independent as they seek to maximize their revenues and survive, they are also interdependent because their success partially depends on the network's success (Flynn et al., 2020). The tension in the supply chain might impact respondents' perceptions, creating biases. There is also a practical limitation; it is challenging to survey all members of a large supply chain to obtain conclusive results. Therefore, our results provide a partial view of the participants based on their role in the network.

Second, regarding common method bias, although we introduced a methodological separation between each construct, explaining the objective of the measures to situate the respondent to reduce the possibility of CMB (Podsakoff et al., 2003) and found no significant evidence statistically, we cannot entirely discard the possibility of its effect.

Third, we surveyed only respondents in the U.S.A. working in the manufacturing sector. Therefore, the results cannot be generalizable to other countries and regions, especially considering the level of technological maturity of firms in the U.S.A. compared with Asia-Pacific hosting most of the supply chain production capacity. Using ERP as a proxy for internal integration adoption, the North American region will continue to dominate the market. However, Asia-Pacific will grow significantly (Keshav, Pamod & Vinnet, 2022).

Fourth, although the sample size of 245 responses is adequate for testing hypotheses, larger samples are better for maximizing accuracy, minimizing errors, and increasing generalizability. Osborne & Costello (2004, p.1) suggest the following sample size scale "50 – very poor; 100 – poor; 200 – fair; 300 – good; 500 – very good; 1000 or more – excellent." Our sample size is between poor and fair, presenting another potential limitation regarding the generalizability of our study.

Finally, we want to mention that we found a lack of discriminant validity between customer and supplier integration constructs, along with correlation among the same constructs and between networked-SCMS and supplier integration. One plausible explanation for the discriminant validity issue is that we surveyed a population with a different view of the supply chain than 15 years ago when it was less known making us reconsider the usage of these scales that, although established over the years of use, might need a review. Regarding collinearity, Flynn et al. (2010) highlight that supply chain integration constructs are highly correlated by nature, which explains part of our finding. In particular, and in connection to the evolution of supply chain integration, respondents might find that sharing information in the supply chain network is the same as joining a networked supply chain management system platform.

CHAPTER VII. DISCUSSION AND IMPLICATIONS

Our findings provide evidence and relevance to studying and adopting technology-enabled supply chain business networks as the next important milestone in the evolution of supply chain integration. They reveal the positive effects of networked-SCMS and information management in the relationship between supply chain integration constructs (internal, customer, and supplier) and operational performance, providing a plausible answer to our research question. Our conceptualization of networked-SCMS is a new generation of best-of-breed enterprise applications helping firms to integrate with their business partners digitally; and designing multi-enterprise processes to decouple the relational information-sharing (Leuschner et al., 2013) from digital integration with customer and suppliers. Networked-SCMS also bridges the internal digital integration provided by the traditional ERPs required by enterprises to run their business with the capability of joining multi-enterprise supply chain business networks. We discuss our results from this perspective.

We found that internal integration (H1) positively affects operational performance. It was the expected result, as internal integration provides the basis for SCI, according to Flynn et al. (2010) and supported by other authors in later studies (Alfalla-Luque et al., 2015; Errassafi et al., 2019; Qrunfleh & Tarafdar, 2014; Srinivasan & Swink, 2015). Our findings reinforce that the implementation and use of ERPs provide the information processing capacity to successfully integrate intra-firm supply chain functions following the OIPT view (Galbraith, 1974). ERPs are essential for focal firms that want to join supply chain business networks. The positive effect of customer integration (H2) on operational performance was also expected and did not differ from previous studies. However, we found that the direct effects are relational. In our conceptualization of a new generation of enterprise applications, sharing information via spreadsheets and data extracts does not provide the support needed to join a supply chain business network. It merely helps the relational exchange between lateral relationships, as proposed by OIPT (Galbraith, 1974). Our findings regarding the direct effect of supplier integration on operational performance (H3) also show a positive effect. This finding is interesting because the literature presents ambiguous results. Our results align with the recent findings of Errassafi et al. (2019), and support the relational aspect between firms and their suppliers. We expected these results since the buyer-supplier relationship is foundational in the supply chain (Ellram & Cooper, 2014). Thinking that the so-called dyadic integration would not significantly affect operational performance was counterintuitive. Our findings provide evidence that firms which, at a minimum, implement ERPs and have a good relationship with their customers and suppliers via lateral relationships, as proposed by OIPT, can experience an improvement in operational performance.

The results for the moderation effects of information management (H4a-c) provide evidence that incorporating the analysis of information into internal and external integrations with customers and suppliers can improve operational performance. Therefore, we suggest that companies build a solid information management approach into their management teams to reduce the natural uncertainty in the supply chain and make better decisions (Galbraith, 1974; Sundram et al., 2018). Our empirical findings reinforce our approach to using OIPT as our theoretical lens; information generates knowledge, whereas the sole exchange of data and data processing capabilities does not

(Tushman & Nadler, 1978). It is an important finding and contribution because the SCI literature does not commonly address information management. Information management is an essential component to evolving our SCI theory and moving toward networked-SCMS. Otherwise, the effort required to join supply chain business networks could potentially negatively impact operational performance. Therefore, we suggest that companies advancing their supply chain integration capabilities must first develop an information management strategy, so they can make sense of the information when joining other companies toward a common business goal (Christopher, 2016).

Our results on the moderation effect of networked-SCMS sustain our claims that focal firms (enterprises) need to evolve their IT strategies to match supply chain needs. They must leave the old vertically integrated enterprise model to an extended supply chain network (Christopher, 2016), where firms remain independent but contribute toward a common business goal. Networked-SCMS presents two moderation effects, first on the effects of information management (three-way moderation) and second on the relationship between supply chain integration components (internal, customer, and supplier) and operational performance. As noted in the results section, the three-way moderation effects were significant – but they weakened, rather than strengthened, the moderation effect of information management. The Yule-Simpson's Paradox (Goltz & Smith, 2010) provided a lens to review the confounding results using conditional effects at -1SD, mean, and +1SD, as reported in Table 12. Since our hypotheses (H5a-c) predict that networked-SCMS will have a positive effect when networked-SCMS is at high levels, our results show that the moderation of information management and internal integration is significant. We expected this result, because information management analyzes scenarios using diverse data sources, and then brings data elements from the network (customers and suppliers) to improve decision-making as external integration permeates into internal integration. The positive moderating effect on information management and customer integration was also significant. We also expected this result, because operational performance reflects customer service efficiencies and the firm's flexibility to sense and respond to customer requirements. Therefore, firms are better equipped to serve their customers and turn to new strategies and product designs, leveraging the information received from their customers. The moderation effects on information management and supplier integration were not supported at the highest level of networked-SCMS, as predicted. However, they were supported at -1SD and mean. This is an exciting finding, both theoretical and practical. Theoretically, this indicates that the confounding results on supply chain integration might result from choosing the wrong statistical approach to understand them. As indicated by Zheng, Kong & Brintrup (2023), companies (mainly when they act as suppliers) do not share data for fear of being outperformed. This behavior helps to explain why the results obtained at lower levels of networked-SCMS are significant. Practically, our results provide evidence that adopting the new generation of networked-SCMS to integrate with suppliers can benefit information management, improving decision-making, planning, and execution toward a common business goal.

In addition, networked-SCMS' moderation effects on the relationship between SCI components and operational performance are significant. We expected these results, which are core to our theorization of networked-SCMS toward a new generation of enterprise applications with embedded SCI capabilities to manage internal and external information processing requirements. Our results provide evidence that enterprises that implement changes in their information system strategy and processing models, in order to expand their processes outside their enterprise boundaries, should consider the networked-SCMS approach. Therefore, reducing the natural levels of uncertainty present in the supply chain by gaining manufacturing, supplier, logistics, and enterprise visibility (Cecere, 2023). Theoretically, our results side with the foundational premise proposed by Carter et al. (2015, p. 90) that "the supply chain is a network, consisting of nodes and links." Although this is not a novel definition, the theory of building a network using digital supply chain integration has not been studied in detail (Industrial Marketing Management, 2021). The results reinforce our theoretical decision to depart from the vertical integration view (Srinivasan & Swink, 2015) toward the network integration of best-of-breed enterprise applications, providing a technological solution to solve business network requirements. In summary, adopting networked-SCMS allows focal firms to meet new business and supply chain integration requirements using a configuration approach to join new communities, avoiding long point-to-point (vertical) integration projects. It helps firms align strategies providing intra and inter-organizational support for decision-making and better planning to outperform rival networks.

While our study contributes to the supply chain integration literature and provides implications for practitioners, it also presents opportunities for future research advancing the digital supply chain integration theory to join multi-enterprise supply chain business networks.

First, as noted in our limitations chapter, there is a need to develop a new scale to measure the supply chain integration constructs with a better distinction in the role of customer and supplier integration, as they are not a mirror of each other. The current instruments, for example, measure the ability to quickly establish an ordering system or share production plans both with customers and suppliers (Flynn et al., 2010). A scale could be developed that incorporates trust as a fundamental construct to join supply chain networks via SCI (Verghese et al., 2020). Our call to develop a new scale acknowledges that studies on SCI and operational performance have been using and adapting the same scales for over 20 years (Feng, Yu, Chavez, Mangan & Zhang, 2017; Flynn et al., 2010; Narasimhan & Kim, 2002; Yu, Huo, Zhang, 2021) without considering the changes in business and advancements in supply chain practice, which could be changing the perceptions of respondents.

Second, other researchers can extend our study using conditional process analysis (Hayes & Rockwood, 2020). We acknowledge that the supply chain is a complex socio-technical and adaptive system (Behdani, 2012; Carter et al., 2015), where each firm controls and operates its resources to maximize its differential advantage, with limited upstream (supplier) and downstream visibility. Thus, as business conditions change, the interaction between firms changes dynamically, making it difficult to manage and study the supply chain network as a predefined system. We suggest approaching the study by identifying supply chain networks as self-organizing complex adaptive systems (Carter et al., 2015). Although conditional process analysis is a relatively new quantitative method, it will allow researchers to study the effects and contingencies under different contexts and stimuli (Hayes & Rockwood, 2020).

Our third recommendation is to develop a digital supply chain integration theory. Most of the contributions to the supply chain borrow from theories and theoretical frameworks from other disciplines. Thus, adapting those theories can cause issues with constructs and the unit of analysis. Our call follows the recommendations from Flynn et al. (2020) to develop a digital SCI theory that uses the supply chain lexicon. It is rooted in the advancements of supply chain integration to digitally connect firms to multi-enterprise supply chain business networks. The goal is to provide clarity to researchers and practitioners by presenting a theoretical framework to explain the "why" behind the SCI digitization phenomena. A recent study shows that large enterprises over $5B have digital supply chain programs; however, their leaders continue to apply traditional approaches, and their enterprises fail to reap the benefits of digitization (Cecere, 2023). A new theory is in high demand to advance the supply chain practice; as Van de Ven (1989) articulated in his article, "Nothing is quite so practical as a good theory."

CHAPTER VIII. CONCLUSIONS

Our study extends prior research on the relationship between supply chain integration and operational performance, introducing the moderation effects of information management and networked-SCMS. In particular, we studied these moderation effects to understand if combining information management with adopting a new generation of networked-SCMS to join multi-enterprise supply chain business networks further improves operational performance. Our results supported and demonstrated that the greater the use of information management combined with networked-SCMS, the stronger the relationship between SCI and operational performance. We hope our research and its results inspire and provoke discussions among supply chain researchers and business leaders. At the crux of the debate is to evaluate transitioning from the traditional SCI approach of implementing non-sustainable point-to-point integrations into a network where a composite of applications representing a pattern of multi-interdependent organizational elements, IT strategy and software enables firms to join business networks to achieve higher levels of operational performance.

Embracing a networked-SCMS requires careful planning; firms must also adopt information management to make sense of and maximize the use of information exchanged with partners in the network. Otherwise, their effort could negatively impact operational performance. Practitioners and researchers must remember that information generates knowledge, whereas the sole exchange of data and data processing capabilities does not.

Sharing information requires special consideration. Our results indicated that firms do not see an increased operational performance at higher levels of networked-SCMS and information management with suppliers. A plausible explanation is that companies might not share data for fear of being outperformed. The new generation of networked-SCMS needs to consider integrating trust elements and improving decision-making, planning, and execution toward a common business goal.

Finally, our research suggests that the path to innovation involves adopting a networked view of the enterprise. Firms joining multi-enterprise supply chain business networks have the potential to improve their relationship with their supply chain partners, improve business visibility, and reduce the natural uncertainty present in the supply chain. These relationships allow the enterprise to deliver superior value in the marketplace and prevail over its competitors.

LIST OF REFERENCES

Agostinho, C., Ducq, Y., Zacharewicz, G., Sarraipa, J., Lampathaki, F., Poler, R., & Jardim-Goncalves, R. (2016). Towards a sustainable interoperability in networked enterprise information systems: Trends of knowledge and model-driven technology. *Computers in Industry*, *79*, Article 79.

Agresti, A. (2018). *Statistical Methods for the Social Sciences* (Fifth). Pearson.

Aguinis, H., Villamor, I., & Ramani, R. S. (2021). MTurk Research: Review and Recommendations. *Journal of Management*, *47*(4), 823–837.

Alfalla-Luque, R., Marin-Garcia, J. A., & Medina-Lopez, C. (2015). An analysis of the direct and mediated effects of employee commitment and supply chain integration on organisational performance. *International Journal of Production Economics*, *162*, 242–257.

Allen, E., & Seaman, C. A. (2007). Likert Scales and Data Analyses. *Quality Progress*.

Babbie, E. (2016). *The Practice of Social Research* (14th ed.). Cengage Learning.

Behdani, B. (2012). *Evaluation of paradigms for modeling supply chains as complex socio-technical systems*. Winter Simulation Conference, Berlin, Germany.

Brown, S. (2010). Likert Scale Examples for Surveys. *Iowa State University Extension*.

Brown, T. A., & Moore, M. T. (2012). Confirmatory Factor Analysis. In *Handbook of structural equation modeling* (pp. 361–379).

Busse, C., Meinlschmidt, J., & Foerstl, K. (2017). Managing information processing needs in global supply chains: A prerequisite to sustainable supply chain management. *Journal of Supply Chain Management*, *53*(1), 87–113.

Büyüközkan, G., & Göçer, F. (2018). Digital Supply Chain: Literature review and a proposed framework for future research. *Computers in Industry*, *97*, 157–177.

Carter, C. R., Rogers, D. S., & Choi, T. Y. (2015). Toward the theory of the supply chain. *Journal of Supply Chain Management*, *51*(2), 89–97.

Cecere, L. (2023, January 18). *Supply Chain Visibility. If It Seems Simple, Look More Closely* [Business and Economic Data]. https://www.forbes.com/sites/loracecere/2023/01/18/supply-chain-visibility-if-it-seems-simple-look-more-closely/?sh=6d006a42388f

Cheng, L., Craighead, C. W., Crook, T. R., & Eckerd, S. (2020). Leaving it on the table? An examination of unrealized bargaining power in multimarket buyer-supplier exchanges. *Journal of Operations Management*, *67*(3), 382–406.

Christopher, M. (2016). *Logistics & Supply Chain Management* (5th ed.). Pearson.

Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation*, *10*(7).

Craney, T. A., & Surles, J. G. (2002). Model-Dependent Variance Inflation Factor Cutoff Values. *Quality Engineering*, *14*(3), 391–403.

Eckhardt, G. M., Houston, M. B., Jiang, B., Lamberton, C., Rindfleisch, A., & Zervas, G. (2019). Marketing in the Sharing Economy. *Journal of Marketing*, *83*(5), 5–27.

Ellram, L. M., & Cooper, M. C. (2014). Supply Chain Management: It's All About the Journey, not the Destination. *Journal of Supply Chain Management*, *50*(1), 8–20.

Errassafi, M., Abbar, H., & Benabbou, Z. (2019). The Mediating Effect of Internal Integration on the Relationship between Supply Chain Integration and Operational Performance: Evidence from Moroccan Manufacturing Companies. *Journal of Industrial Engineering and Management*, *12*(2), 254–273.

Feng, M., Yu, W., Chavez, R., Mangan, J., & Zhang, X. (2017). Guanxi and operational performance: The mediating role of supply chain integration. *Industrial Management & Data Systems*, *117*(8), 1650–1668.

Flynn, B., Baofeng, H., & Xiande, Z. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management*, *28*, 58–171.

Flynn, B., Pagell, M., & Fugate, B. (2018). Editorial: Survey Research Design in Supply Chain Management: The Need for Evolution in Our Expectations. *Journal of Supply Chain Management*, *54*(1), 1–15.

Flynn, B., Pagell, M., & Fugate, B. (2020). From the Editors: Introduction to the Emerging Discourse Incubator on the Topic of Emerging Approaches for Developing Supply Chain Management Theory. *Journal of Supply Chain Management*, *56(2)*, 3–6.

Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: An international study of supply chain strategies. *Jour of Operations Management*, *19*, 185–200.

Galbraith, J. R. (1974). Organization design: An information processing view. *Interfaces*, *4*(3), Article 3.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. *Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education*.

Goltz, H. H., & Smith, M. L. (2010). Yule-Simpson's Paradox in Research. *Practical Assessment, Research, and Evaluation*, *15*(15), 1–9.

Hair, Jr., J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (Second). SAGE Publications, Inc.

Hayes, A. F., & Rockwood, N. J. (2020). Conditional Process Analysis: Concepts, Computation, and Advances in the Modeling of the Contingencies of Mechanisms. *American Behavioral Scientist*, *64*(1), 19–54.

Helfat, C. E., & Campo-Rembado, M. A. (2016). Integrative Capabilities, Vertical Integration, and Innovation Over Successive Technology Lifecycles. *Organization Science*, *27*(2), 249–264.

Hu, L., & Bentler, P. M. (1999). Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55.

Iacobucci, D., Schneider, M. J., Popovich, D. L., & Bakamitsos, G. A. (2016). Mean centering helps alleviate micro but not macro multicollinearity. *Behavior Research Methods*, *48*, 1308–1317.

Industrial Marketing Management. (2021, August). *Technology-enabled multi-sided platforms in B2B settings: Challenges and opportunities for supply chain ecosystems* [Journal]. https://www.journals.elsevier.com/industrial-marketing-management/call-for-papers/technology-enabled-multi-sided-platforms-in-b2b-settings-challenges-and-opportunities-for-supply-chain-ecosystems

Infor. (2021). Infor Nexus [Commercial]. *Real-Time Supply Chain Visibility and Insight*. https://www.infor.com/solutions/scm/infor-nexus

Kaiser, H. F., & Rice, J. (1974). Little Jiffy, Mark IV. *Educational and Psychological Measurement*, *34*, Article 34.

Kaufmann, L., Schreiner, M., & Reimann, F. (2022). Narratives in supplier negotiations—The interplay of narrative design elements, structural power, and outcomes. *Journal of Supply Chain Management*, *59*(1), 66–94.

Keshav, K., Pramod, B., & Vineet, K. (2022, February). Enterprise Resource Planning (Erp) Market Statistics: 2027 [Commercial]. *Allied Market Research*. https://www.alliedmarketresearch.com/ERP-market

Leuschner, R., Rogers, D. S., & Charvet, F. F. (2013). A Meta-Analysis of Supply Chain Integration and Firm Performance. *Journal of Supply Chain Management*, *49*(2), 34–57.

Liu, H., Wei, S., Ke, W., Wei, K. K., & Hua, Z. (2016). The configuration between supply chain integration and information technology competency: A resource orchestration perspective. *Journal of Operations Management*, *44*, 13–29.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample Size in Factor Analysis. *Psychological Methods*, *4*(1), 84–99.

Matsunaga, M. (2010). How to Factor-Analyze Your Data Right: Do’s, Don’ts, and How-To’s. *International Journal Psychological Research*, *3*(1), 97–110.

Narasimhan, R., & Kim, S. W. (2002). Effect of supply chain integration on the relationship between diversification and performance: Evidence from Japanese and Korean firms. *Journal of Operations Management*, *20*, 303–323.

Osborne, J. W., & Costello, A. B. (2004). Sample size and subject to item ratio in principal components analysis. *Practical Assessment, Research, and Evaluation*, *9*(11), 1–9.

Osborne, J. W., & Overbay, A. (2004). The power of outliers (and why researchers should ALWAYS check for them). *Practical Assessment, Research, and Evaluation*, *9*(6), 1–8.

Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, *5*(5), 411–419.

Peer, E., Vosgerau, J., & Acquisti, A. (2013). Reputation as a sufficient condition for data quality on Amazon Mechanical Turk. *Behavior Research Methods*, *46*, 1023–1031.

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.

Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics*, *135*, 514–522.

Qrunfleh, S., & Tarafdar, M. (2014). Supply chain information systems strategy: Impacts on supply chain performance and firm performance. *International Journal Production Economics*, *147*, 340–350.

Ried, L., Eckerd, S., Kaufmann, L., & Carter, C. R. (2021). Spillover effects of information leakages in buyer–supplier–supplier triads. *Journal of Operations Management*, *67*, 280–306.

SAP. (2022a). SAP Business Network [Commercial]. *What Can SAP Business Network Do for Your Business?* https://www.sap.com/products/business-network.html

SAP. (2022b). SAP S/4 HANA Cloud ERP Software Solution [Commercial]. *SAP S/4HANA Cloud Discover the Cloud ERP for Every Business Need.* https://www.sap.com/products/erp/s4hana.html

Soper, D. S. (2022). Free Statistics Calculators. *A-Priori Sample Size Calculator for Structural Equation Models*. https://www.danielsoper.com/statcalc/default.aspx

Srinivasan, R., & Swink, M. (2015). Leveraging Supply Chain Integration through Planning Comprehensiveness: An Organizational Information Processing Theory Perspective. *Decision Sciences*, *46*(5).

Sundram, V. P. K., Bahrin, A. S., Munir, Z. B. A., & Zolait, A. H. (2018). The effect of supply chain information management and information system infrastructure: The mediating role of supply chain integration towards manufacturing performance in Malaysia. *Journal of Enterprise Information Management*, *31*(5), 751–770.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55.

Titze, C., & McNeill, W. (2021). *Magic Quadrant for Multienterprise Supply Chain Business Networks* (Magic Quadrant No. G00733898; p. 35). Gartner. https://www.gartner.com/reviews/market/multienterprise-supply-chain-business-networks

Tushman, M. L., & Nadler, D. A. (1978). Information Processing as an Integrating Concept in Organizational Design. *Academy of Management Review*.

U.S. BUREAU OF LABOR STATISTICS. (n.d.). [Government]. Retrieved April 24, 2022, from https://www.bls.gov/

Van de ven, A. H. (1989). Nothing Is Quite So Practical as a Good Theory. *Academy of Management Review*, *14*(4), 486–489.

Verghese, A. J., Koufteros, X., Schoenherr, T., & Vanpoucke, E. (2020). Is relationship evolution good or bad? It depends! A qualitative and quantitative examination of the relational behaviors and the stimulants of supply chain integration. *Decision Sciences*, *2021*, 1–25.

Wu, I.-L., Chuang, C.-H., & Hsu, C.-H. (2014). Information sharing and collaborative behaviors in enabling supply chain performance: Asocial exchange perspective. *International Journal of Production Economics*, *148*, Article 148.

Yu, Y., Huo, B., & Zhang, Z. (Justin). (2021). Impact of information technology on supply chain integration and company performance: Evidence from cross-border e-commerce companies in China. *Journal of Enterprise Information Management*, *34*(1), 460–489.

Zheng, G., Kong, L., & Brintrup, A. (2023). Federated machine learning for privacy preserving collective supply chain risk prediction. *International Journal of Production Research*, 1–16.

APPENDIX A: SURVEY

Table 14

Measurement Items

(Items in italics were discarded from the final survey for data collection to perform hypotheses testing.)

Factor	Item
Qualifiers Scale: single option Prompt: Please complete the following qualifying activity to proceed with the survey.	
Factor	Item
QUA1	Do you work in a B2B (business-to-business) company where your customers are other business organizations? (No, Yes) Fill the blank showing your expertise in manufacturing and supply chain. These acronyms are used in everyday conversations and are possibly shown on the screens and reports of your enterprise application.
QUA2	Fill the blank. Please complete the following sentence with one of the available options. OTIF is a commonly used measure for assessing ___________. (production capacity, supplier performance, stock levels)
QUA3	Fill the blank. Please complete the following sentence with one of the available options. ATP date gives information to ___________. (provide a valid delivery date to your customers, provide a valid payment date to your supplier, provide a valid ex-factory date to your customers)
QUA4	Fill the blank. Please complete the following sentence with one of the available options. WIP is a key input in calculating ___________. (a customer's outstanding balance due in the next 30 days, a sub-assembly or finished good inventory in production, the shelf space required in the warehouse to store a given sub-assembly or finished good quantity)
Demographics Scale: single option Prompt: Select the option that describes yourself and your organization best	
Factor	Item
DEM1	Which of the following most closely describes your job title: (Sales Manager; Procurement Manager; Materials Planner; Customer Account Specialists; Other [specify])
DEM2	Industry: (Aerospace and Defense; Automotive; Chemicals; Life Sciences; Oil and Gas; Industrial Manufacturing; Industrial Machinery; High-Tech & Electronics; Fashion; Distribution; Retail; Other [specify])

DEM3	Years of experience in manufacturing and supply chain? (<1; 1-5; 6-10; 11-15; 16-20; 21-25; >25)
DEM4	What is the approximate total number of employees that your organization has? (1-49; 50-999; 1,000-4,999; > 5,000; Don't know; Other [specify])
	The following sections refer to major customers representing most of your organization's revenue and suppliers representing most of your organization's spending. So, please consider them when answering. Before beginning, please indicate.
DEM5	How many customers approximately represent 80% of your sales? (1-25; 26-50;51-100; >100)
DEM6	How many suppliers approximately represent 80% of your procurement? (1-5; 6-10; 11-15; 16-20; 21-25; >25)

Construct: Customer Integration - Source: Flynn et al. (2010)
Scale: 1 = not at all; 5 = to a great extent
Prompt: This section measures the extent of integration between your organization and your major customers. Customer integration involves using standard processes and exchanging information to incorporate strategic customer requirements into your company's planning and execution processes to react to market conditions and changes in demand to improve customer satisfaction.

Please respond to the following questions:

Factor	Item
CUS1	To what extent do your major customers share market information with your organization?
CUS2	*To what extent is the communication between your organization and your major customers to discuss their market needs?*
CUS3	To what extent can your organization establish a quick ordering system with your major customers?
CUS4	To what extent does your organization follow up with your major customers for feedback?
CUS5	*To what extent does your organization periodically contact your major customers to discuss their requirements?*
CUS6	To what extent do your major customers share demand forecasts with your organization?
CUS7	To what extent does your organization share inventory levels with your major customers?
CUS8	To what extent does your organization share production plans with your major customers?

Construct: Internal Integration - Source: Flynn et al. (2010)
Scale: 1 = not at all; 5 = to a great extent
Prompt: This section measures the extent of internal integration in your organization. Internal integration is the organizational practice of using processes and data integration among departments to improve new product development and planning to fulfill customer requirements and achieve common business goals with suppliers.

Please respond to the following questions:

Factor	Item
INT1	To what extent is your organization's data integration level among internal functions?
INT2	To what extent is your organization's enterprise application integration level among internal functions?
INT3	To what extent does your organization have a centralized inventory management system?
INT4	To what extent does your organization perform periodic interdepartmental meetings among internal functions?
INT5	To what extent does your organization use cross-functional teams in process improvement?
INT6	To what extent does your organization use cross-functional teams in new product development?

Construct: Supplier Integration - Source: Flynn et al. (2010)
Scale: 1 = not at all; 5 = to a great extent
Prompt: This section measures the extent of integration between your organization and your major suppliers. Supplier integration involves exchanging strategic information to incorporate demand, production capacity, and inventory for planning and using standard procurement processes to execute a common business goal to serve the customer better.

Please respond to the following questions:

Factor	Item
SUP1	*To what extent can your organization establish a quick ordering system with your major suppliers?*
SUP2	*To what extent is the level of the strategic partnership between your organization and your major suppliers?*
SUP3	*To what extent is the level of participation between your organization and your major suppliers in your procurement process?*
SUP4	*To what extent is the level of participation between your organization and your major suppliers in your production process?*
SUP5	To what extent is the level of participation between your organization and your major suppliers during your design stage?
SUP6	To what extent do your major suppliers share their production schedules with your organization?
SUP7	To what extent do your major suppliers share their production capacity with your organization?
SUP8	*To what extent do your major suppliers share their inventory quantities with your organization?*
SUP9	To what extent does your organization share production plans with your major suppliers?
SUP10	To what extent does your organization share demand forecasts with your major suppliers?

SUP11	To what extent does your organization share inventory quantities with your major suppliers?
SUP12	*To what extent does your organization help your major suppliers to improve their processes to meet your needs better?*

Construct: Operational Performance - Source: Flynn et al. (2010)
Scale: 1 = strongly disagree; 5 = strongly agree
Prompt: This section measures your organization's capabilities to serve its customers. Operational performance reflects firms' customer service efficiency and flexibility to sense and respond to environmental changes to serve their customers better.

Please indicate the degree to which you agree to the following statements:

Factor	Item
OPF1	My company can quickly modify products to meet our major customer's requirements.
OPF2	My company can quickly introduce new products into the market.
OPF3	My company can quickly respond to changes in market demand.
OPF4	My company has an outstanding on-time delivery record to our major customers.
OPF5	The lead time for fulfilling customers' orders (the time which elapses between the receipt of customer's order and the delivery of the goods) is short.
OPF6	My company provides a high level of customer service to our major customers.

Construct: Networked SCMS - Source: Prajogo & Olhager (2012); Flynn et al. (2010); Sundram et al. (2018)
Scale: 1 = not at all; 5 = to a great extent
Prompt: This section measures your organization's extent of use of information networks to achieve business integrations. Networked supply chain management systems are business applications helping firms to digitally integrate with their business partners (customers and suppliers) to pursue shared objectives by exchanging information and using multi-enterprise processes.

Please respond to the following questions:

Factor	Item
NSM1	To what extent is the information exchange between your organization and your major suppliers through information networks?
NSM2	*To what extent is the level of information exchange between your organization and your major customers through information networks?*
NSM3	To what extent is the integration among information systems in your network so that each member knows other members' requirements and status?
NSM4	*To what extent does your organization use information technology-enabled transaction processing?*
NSM5	To what extent does your organization have electronic collaboration capabilities with your major suppliers through information networks?

NSM6	To what extent does your organization transfer purchase orders with your major suppliers through information networks?
NSM7	To what extent does your organization transfer invoices with your major customers through information networks?
NSM8	*To what extent does your organization use electronic funds transfer through information networks?*
NSM9	To what extent does your organization use advanced information systems to track shipments through information networks?
NSM10	*To what extent does your organization use advanced information systems to expedite shipments through information networks?*

Construct: Information Management - Source: Sundram et al. (2018); Prajogo & Olhager (2012);
Scale: 1 = strongly disagree; 5= strongly agree
Prompt: This section measures your organization's ability to manage the information shared and received from your business partners. Information management consists of the strategies to manage digital information along the supply chain network with business partners for decision-making and to achieve common planning and execution of business goals.

Please indicate the degree to which you agree to the following statements:

Factor	Item
INM1	My organization timely disseminates the information along the supply chain.
INM2	My organization performs joint production planning and scheduling among suppliers, manufacturing, marketing, and distributor.
INM3	My organization achieves inter-organizational coordination using information networks.
INM4	My organization practices efficient information flows along the supply chain.
INM5	My organization has accurate information available for decision-making.

Verification
Scale: single option

Factor	Item
VER1	Please enter the year you started your manufacturing and supply chain career.

APPENDIX B: INFORMED PILOT INVITATION AND RESPONSES

Expert Panel Pre-Test Invitation

Dear colleague,

I am reaching out to you for help with my dissertation work. As a supply chain management expert, I want your feedback regarding the survey I plan to collect respondents' perceptions about supply chain integration, multi-enterprise business networks, and information management.

The survey has several sections, each one of them addressing an area that I want to measure. There is an explanation of what the section measures and a definition of the area. At the end of the section is a space to add your comments.

Could you please comment on the following:

1. Do you find the explanations helpful in providing context for your answers?
2. Do you have problems understanding the questions or the statements?
3. Are the questions relevant?
4. Do the questions provoke discomfort in you?

There is also a space for you to provide feedback for the survey. Could you please comment on the following:

1. Does the consent form provide the correct information to frame the research purpose?
2. What is your overall perception?
3. What can I improve?

Please use this link [https://fiu.qualtrics.com/jfe/form/SV_9nLq6OUlkbXR5Ns] to access the survey, which will be open for a week. Let me know what questions you have.

I appreciate your critical opinion and help.

Lisandro

Table 15

Expert Panel - Pre-Test Responses Feedback

	1. Do you find the explanations helpful in providing context for your answers?	2. Do you have problems understanding the questions or the statements?	3. Are the questions relevant?	4. Do the questions provoke discomfort in you?
EXP1	Yes	CUS2: The phrasing of "quick ordering system" made me pause briefly, because I was trying to figure out if you meant to initially establish a collaborative order system or the system had the ability to quickly process orders. Maybe replace "quick" with "efficient" INT1: I don't understand the context of the word "level"—I read this as asking how well internal functions share data? INT1: after reading INT2 and INT3, which ask about specific applications, I'm unclear about what type of data integration INT1 references. Is INT1 the over all company, and then INT2 and INT3 try to break down the answer into specific areas? SUP1: I assume by design phase you are talking about a new application design? Process design? Both? The rest of the questions assume there is already an integration or application in	I thought the questions were very relevant and intelligently organized	These are not questions that will make anyone uncomfortable

	place and you are measuring the integration that currently exists NSM4 & NSM5: The word “transfer” might be better replaced with “transact” NM4: Maybe replace “quick” with “efficient”
EXP2	CUS2: I am not clear if this is asking whether the organization already has (or whether it *can* establish) an ordering system. Maybe rephrase (if I am understanding the semantics): INT1: To what extent are your organization's internal functions integrated around data exchange? INT2: To what extent are your organization's internal functions' enterprise applications integrated? For INT3: Is integrative the same as integrated? I would write "Please indicate the degree to which you agree *with* the following statements:" otherwise it sounds like a contract, not a survey. OPF1: My company can quickly modify products to meet our major customers' requirements. (apostrophe after the S since they presumably are customers - plural) Small typo in OPF2: "PMy company can quickly introduce new products into the market." NSM1,2: I still think "To what extent is the level" is a

		little odd formulation wise. It sounds a bit like "What is the extent of the extent" or "What is the level of the level", so I might tweak in the same pattern I suggested in the first section. Not a huge deal if left as is, because the meaning is evident either way.		
EXP3	Yes	No	Yes they are	Some of the customer satisfaction ones could but I think they are fine as this is things people know. Not sure how truthfully people answer them but sure you have that info from past surveys.
EXP5		The term "quick ordering system" in question CUS2 might not be clear to all respondents INT2 is a little clumsy to read and understand. Questions are all relevant and provoke good thought for discussion OPF4 - is there a risk of how different organizations measure OTIF? Should you provide a definition for consistency? OPF6 is very subjective and could sku results. Org might believe they are performing at a high level while customer is still dissatisfied NSM3 could easily assume		

		that EDI as an example is the same as "electronic collaboration" in the way you are trying to measure it (example, see NSM4) INM3 is too vague, same with INM4 - seems to require some context - what is "quick"?		
EXP6	Yes, I find the explanation s helpful and very much appropriate	I do not have problems understanding the questions or statements. Just a small typo: Operational Performance section: OPF2 reads as PMy company	I believe the questions/state ments to be relevant	No discomfort. Initially, I wondered whether people would want to answer some of these but as you're not asking for details, I think you'll be fine

Table 16

Expert Panel - Pre-Test Responses Overall Feedback

	Does the consent form provide the correct information to frame the research purpose?	What is your overall perception?	What can I improve?
EXP1	The consent form has all the information necessary.	My initial perception is that the consent form is too long and too much. I don't know if you have some requirements from FIU requiring all of those categories, but if not I think you could remove some. I was surprised by the presence of the discussion about discomfort.	In the summary box you should add that the results will be confidential. That's probably the most important thing to people after telling them how long it will take to do the survey. If you need to keep the detailed categories of the consent form, I would simplify the summary and then allow them to scroll through the more detailed sections below. Here are the categories I would keep in the Summary: 1. Purpose 2. Procedure 3. Duration 4. Confidentiality
EXP2		I thought it was structured logically and asked relevant questions, to the extent that I have insight into the subject matter.	
EXP3	Yes	Felt like it was great	I expect there is a methodology you need to follow but was wondering if you could add an answer 'not applicable' or similar (guessing not) and is it possible to share results as

			a benefit. Both just thoughts.
EXP5	Consent form is good.	Each section is very targeted and clear, although as indicated a few of the questions may benefit from some additional definition/ specificity. Consent form is good.	It's clear what you are trying to measure and I genuinely like the methodical and systematic approach you move through supply chain processes without feeling redundant in the questions.
EXP6	The consent form provides the correct and appropriate information	My overall perception is that you are very thorough and that I would love to see the outcome of this survey	The only thing I would suggest, and I'm not sure your system will allow it, but we find that having a progress bar showing how much of the survey has been completed vs how much remains, increases the chances of someone completing a survey.

VITA

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PUBLICATIONS AND PRESENTATIONS

Sciutto, L. (2023). Understanding the Influence of Digital Technologies in the Trust Building Process Among Buyer-Suppliers in a Supply Chain Business Network. In *Proceedings of the Twelfth International Conference on Engaged Management Scholarship-EMS*. Available *at SSRN 4322736*.

Sciutto, L. (2022). The era of network competition: Towards a new generation of networked supply chain management systems improving operational performance. Poster Presentation and Doctoral Consortium. *Twelfth International Conference on Engaged Management Scholarship-EMS at Universidad Panamericana Campus Guadalajara – Mexico*.

Sciutto, L. (2022, January). Network Competition and the Role of Supply Chain Integration. Guest Lecturer. *Professional MBA*, *Operations Management, University of Florida*.

Sciutto, L. (2021, October). Towards a Networked Supply Chain Management System: A New Generation of Enterprise Software Application. In *Proceedings of the Eleventh International Conference on Engaged Management Scholarship-EMS*.

Sciutto, L. (2021, March; 2021, October). Selling Enterprise Software in Latin America – A perspective view with a Product management lens. Guest Lecturer. *Professional MBA*, *B2B Marketing, University of Florida*.