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Assessing Recent Trends in Supply Chain Management, Technology Adoption and Performance in Storage Sector

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ABSTRACT: The electrophysiological changes that accompany Parkinson's disease are expressed not only functionally related sensor groups, and a Chebyshev spectral convolution propagates information over this higher-order structure. A temporal convolutional network with dilated causal filters models the non-stationary evolution of connectivity, and a squeeze-and-excitation module recalibrates the five band streams before classification. On the public University of California San Diego resting-state dataset the network reaches 97.85 percent accuracy, a 97.80 percent F1-score and an area under the curve of 0.998 under a stratified protocol, and it preserves 90.36 percent accuracy under a subject-independent protocol. Ablation and interpretability analyses confirm that directed beta-band coupling over sensorimotor cortex drives the decision.

INTRODUCTION

According to Halldorsson, et al., (2017), there is still a lack of theoretical support for understanding and explaining the reality or boundaries of SCM. In short, the below-average performance of supply chains can be improved by understanding the potential of supply chain management (SCMP) and implementing supply chain technology. The research that addresses the connection between SCMP competencies and the implementation of supply chain technology in the service sector is still in its early stages, as noted by Qian, et al. (2022). This situation reflects a broader gap in the literature that requires a solution. During the global economic downturn, organizations did not face the remarkable effects that were observed during the economic advancements.

In China; for example, consumers were cautious in their purchasing behavior, yet they faced significant challenges with escalating demand and financial capability in choosing between multiple brands. Cold storage, as one of the most extended distribution mediums, remains highly competitive. Internationally, factors are discussed regarding the types of competencies of supply chain management that are essential for remaining competitive, as well as the impact of these competencies on outcomes, along with the implementation of supply chain technology. This discussion concludes that there is still a need for improvement in the cold storage sector, particularly in the development of supply chain capabilities

and the adoption of supply chain technology. The ongoing research focuses on elements that impact the competencies of supply chain management and the implementation of supply chain technologies in the cold storage sector.

The Supply Chain Council (2010) claimed that the implementation of the Supply Chain Operations Reference (SCOR) model by numerous corporations globally; incorporating producers, suppliers, vendors, and service operators; has demonstrated its utility. However, research into the execution of supply chain management in the services sector has been limited (Fynes, Burca & Voss, 2015). The factors that investigate the proficiency of the supply chain, including all participants in the entire supply chain, include dependability, reactivity, flexibility, cost, and capital management efficiency. The SCOR framework provides a diverse perspective on cooperative working environments, as argued by authors such as Zeng, et al., (2017) and Gao, et al. (2021). This highlights the continued relevance of studying SCM in business literature.

In the current study, the main focus is on supply chain operational performance (SCOP), rather than financial performance (Shahzad, et al., 2018; Shahzad, Farrukh, & Kanwal, (2018). Experimental data indicates that factors from the SCOR framework help probe the proficiency of the supply chain. There is a need for research on the impacts of supply chain management competencies and the implementation of supply chain technology on supply chain operational performance, especially regarding adaptability, cost, reliability, and responsiveness. Recent data show that the implementation of supply chain technology has mediating effects on the functional efficiency of supply chains, due to intense competition, complexity, and uncertainty in the cold storage commercial environment (Ahmadi, Hesaraki, & Morsch, 2025). Thus, this research aims to examine the relationship between logistical competencies,

operational technology, competencies, and supply chain performance in the cold storage sector. To enhance SCOP in the cold storage sector, it is crucial to explore the competencies associated with supply chain management and the implementation of technology in improving SCOP.

Furthermore, Supply Chain Collaboration (SCC) remains underutilized, hindering the potential for seamless coordination and improved decision-making. A crucial gap exists in understanding how supply chain technology adoption (TA) mediates the relationship between IS, IT capabilities, and OCC with SCOP. The adoption of advanced supply chain technologies can act as a catalyst for efficiency, yet empirical evidence on its role within the cold storage industry remains scarce. This study aims to bridge this gap by investigating the interplay between these key factors, focusing on the role of technology adoption as a mediator, and emphasizing the need for strategic technology implementation to enhance SCOP. By addressing these critical dimensions, this research will contribute to the development of a more resilient and efficient cold storage supply chain framework. by keeping in view the above discussion current study has two main objectives, as; To investigate the effect of Supply Chain Management Practices (SCMP), Information Technology Capabilities (ITC) and Supply Chain Capabilities (SCC) on Supply Chain Operational Performance (SCOP) among Chinese cold storage firms. To investigate the effect of Supply Chain Management Practices (SCMP), Information Technology Capabilities (ITC) and Supply Chain Capabilities (SCC) on Technology Adoption (TA) among Chinese cold storage firms.

LITERATURE

Empirical Studies on Supply Chain Management: In recent years, the goal of researchers and supply chain professional performance has become increasingly competitive with prices, although in the past emphasis was placed on minimizing or improving prices (Chen and Yano, 2010; Shahzad, FARRUKH, and YASMIN, (April, 2020). To achieve true value excellence in the supply chain, one must take five steps: employing the right people, utilizing the appropriate technology, collaborating internally and externally, and making adjustments to supply chain management. These days, supply chain rivalry is fiercer than rivalry between individual businesses in the market. Accordingly, efficient supply chain management has thus emerged as a successful tactic to guarantee a competitive advantage in the cutthroat market. As a result, enhancing supply chain performance is now crucial for any organization competing in the market (Agami et al., 2012; Gao, E., et al., 2021).

In a rapidly changing market environment, speed of response is key to significantly improving supply chain performance (Sinkovics, Jean, Ross, & Cavusgil, 2011; Leng et al. 2024). Therefore, to respond more quickly to customer needs, companies have to compete in today's rapidly changing market. Meanwhile, the technical support necessary to meet strict time

and quality objectives improves customer responsiveness (Christopher et al., 2004). Typically, the supply chain reaction is aimed at minimizing costs, improving speed, and improving flexibility (Gunasekaranet al., 2008). From an operational point of view, understanding customer needs is a very delicate task that can be beneficial for higher performance (Zandi, et al., 2021). However, some studies suggest that the manufacturer-related industry is not fully effective in rapid response, hampered by lack of response accuracy and response time (Wang et al. 2024). However, authors identified that the latest research shows that supply chain response, resulting in a service-oriented organization, is increasing.

Researchers proposed and implemented agility, flexibility, and reconfigurability to satisfy our customers (Gligor & Holcomb, 2012A; Tang et al. 2023) through rapidly changing manufacturing needs. Research has shown that flexibility can be achieved in the supply chain to integrate all available resources, including technology, people and organizations. At the sametime, partnerships with suppliers are vital to achieve agility in response to rapidly changing market demand (Jin et al., 2005). Ding, Weng, and Chou (2023) study suggested involving board executives to ensure agility in operations and improve performance.

Therefore, agility is becoming one of the contemporary and modern SMC tools (Zhang et al. 2023) that have main characteristics. With constant market demand, there have been a number of technology companies managing their supply chains more flexibly, but most ofthem are underdevelopment (Vinodhet al, 2011). However, there are a different number of flexible characteristics defined in various studies. Christopher (2011) characterizes the terms of supply chain agility by two factors, namely flexibility and adaptability; while Li et al., (2014), said that it has six factors, including the ability to respond to business alerts, operations, supply chain agility, strategic awareness, strategic response capability, incidental alertness and sporadic response capability.

Empirical Study of Supply Chain Management and Supply Chain Operational Performance: SCM's primary goal is to meet customer demands by delivering the proper product (Boubekri, 2001), in the right quantity (Yang, & Ma 2015), at the right price, from a reliable source and, lastly, utilizing the right technology. Accordingly, SCMPs are seen as operational functions or activities of an organization that assess the supply chain's efficacy and efficiency (Kayakutlu & Buyukozkan, 2010). Additionally, it has been demonstrated that SCMP isa multidimensional notion, thus it should be understood in the context of a larger, more comprehensive concept (Song, 2015).

Tan et al. (2002) defined "six dimensions of supply chain management practices, namely, supply chain characteristics, customer service management, geographic proximity, supply chain integration, just-in-time capability, and information sharing" while Chen and Paulraj (2004) claimed others as "dimensions to measure SCMP, such as supplier base reduction, long-term relationships, communication, cross-functional teams, and supplier involvement." Furthermore, Min and Mentzer (2004) found as "supply chain leadership, risk and reward sharing, agreed vision and objectives, information sharing, long-term relationships, process integration and cooperation." Mentzer et al. (2001) proposed that in order to successfully implement supply chain management, the following activities are required: integrated behavior, process integration, mutual information exchange, cooperation, goal congruence, the same focus on client service, and the creation and maintenance of long-term relationships (by partners).

This is consistent with the suggestions made (CHENG, LIU & ZHOU, 2017; LI & ZHAO, 2018). However, in terms of coordination and integration, the latter implies that the only tightly related interactions are those that are most appropriate and fit certain sets ofconditions. It is worthwhile to look into each ofthese actions to see how they impact supply chain performance and integration levels.

Therefore, according to the material mentioned above, SCMP offers a variety of dimensions and viewpoints that eventually enhance performance both inside and outside the company. Overall, the literature included a number of significant SCMP dimensions, such as the supply chain's internal structure, flow across the chain, downstream supply chain, and supply chain system approach. While each of these

aspects is effectively measured and examined, they are not examined in the same setting and are instead tested independently. Because of this, the above study's findings will not accurately reflect the full extent of the SCMP's influence on supply chain and organizational performance. Thus, the current study suggests that SCM methods are a multifaceted idea (Zhang, 2019).

Supply Chain Management Practices and Supply Chain Operational Performance: "Information sharing (IS) refers to the degree to which critical and proprietary information is communicated between supply chain members regarding market, product, and customer information" (Li, Ragu-Nathan, et al., 2006). Furthermore, "the effort made to provide information and make it visible to other parts of the supply chain allows business decisions to be made quickly and accurately as a source of competitive advantage" (WANG, DU 2016; Andiana, Kusmantini, & Nilmawati 2024). As such, "information sharing is considered as the terminator of the 'bullwhip effect'" (Fiala, 2005) and "reduces the total supply chain cost to achieve efficient supply chain performance" (Khan, Akhtar, Zhang, & Khan 2024).

Information exchange can be classified into vertical or horizontal categories. Vertical information is shared between manufacturers and retailers along the supply chain, while horizontal information is shared within the same level (Lee, 2000). Information exchange can have both direct effects, derived from active participation, and indirect effects or leaks, which can influence rival strategies (Nzeako, et al., 2024). Yu, Yan, Cheng (2002), classify information exchange into three levels: distributed control, coordinated control and centralized control. At the distributed control level, individual members monitor their inventory independently.

Coordinated control involves integrating inventory and customer order information to make informed decisions. Centralized control involves synchronized access to customer demand information through EDI applications for optimal performance. Hui and Lingrong (2012) and similarly, Chen, Dan, Ma, and Tian (2024) identified four levels of information sharing: no sharing, partial sharing, almost full sharing, and full sharing. Although a complete exchange of information is ideal, it is often impractical due to privacy and security concerns.

Information can be shared both in terms of quantity and quality. The exchange of high-quality and accurate information is vital for a competitive supply chain (Aladwey & Alsudays 2024). Effective information sharing fosters stable relationships within the supply chain (Cook, Heiser, & Sengupta, 2011) and is crucial to improving textile and apparel supply chain performance Surucu-Balci, Iris, and Balci (2024). Lack of information sharing can lead to suboptimal supply chain performance (Xu and He 2024).

Information Technology Capabilities (ITC) and Supply Chain Operational Performance: Authors defined the infrastructure, "the combination of technology and human components. Technology infrastructure refers to applications of hardware, software, communications technology and data, while part of human knowledge refers to commitment, experience, skills, rules, abilities, values and employees. Therefore, it is complex and difficult to imitate" (Barney, 1991). Samad, eta l., (2023) all components further define the technical infrastructure, applications, software and improve operations, processes and create all the physical components of various functions within the organization. Although Bharadwaj, (2000) defines business infrastructure, communications technology and computing platforms and databases as shared technology.

It provides a basis for the formulation and implementation of internal communication and sharing of current and future business applications throughout the organization.

However, inappropriate use of technology is E-SCM (Xia, Li, & He 2023) one of the obstacles to development.

According to Bharadwaj (2000), FIRM infrastructure is a competitive weapon that can be used to manage resources and is essential in the highly competitive market. Effective businesses reinvent their goods and services and make advantage of their infrastructure (Zhou, et al., 2024). As a result, selecting an infrastructure is becoming one of the most important factors in determining a company's competitiveness. Companies should pay special attention to implementing dynamic changes in a variety of international commercial transactions and business processes. An effective management infrastructure that enables businesses to hire more people and cut production times, increase production costs and improve the Internet (Yadegari, Mohammadi, & Masoumi, 2024)

Scholars and industry professionals have noted that supply chain integration and performance are directly impacted by the value potential of IT infrastructure firms (Ning, Li, Xu, & Yang, 2023). From a statistical perspective, this is because, according to Byrd and Turner (2000), infrastructure spending accounts for more than 58% of corporate IT budgets, with this percentage growing at a rate of 11% annually. The features of infrastructure decisions are demonstrated by the statistics findings. The ability to leverage IT for competitive businesses (Duncan, 1995) and the utilization of IT infrastructure for business value (Byrd and Turner, 2000) have a significant impact.

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Supply Chain Capabilities (Organizational Culture) and Supply Chain Operational Performance: Global businesses must build distinct, unmatched talents to optimize their potential globally in order to flourish in worldwide business (Barney, 1991). This study emphasizes the importance of trust (Gulati, 1995), organizational culture (Parkes et al., 2001), and strategic sourcing (Chopra & Meindl, 2010; Zhou, Long, & Govindan 2024) in enhancing supply chain capabilities. It is based on these three theories. They are discussed below;

In general, a society's language, customs, beliefs, rituals, laws, institutions, and practices all come together to form its culture (Schniederjans, Schniederjans, & Schniederjans, 2010). Since the early 1980s, anthropologists and other organizational researchers have extensively researched organizational culture (Hofstede, Hofstede, & Minkov, 2010). As a result, a wealth of definitions resulted from Hofstede. Organizational culture was defined as a collection of common beliefs and presumptions about how organizations operate. It can also be broadly described as a collection of employee behaviors and actions within a company that influence how individuals and groups interact with one another (Colovic, 2012). On the other hand, personnel, training, remuneration, evaluation, and common values, attitudes, presumptions, and beliefs of employees inside the business can all be considered aspects of culture (Colovic, 2012; Zhang, Venkatesh, & Ohana 2024).

"Innovation involves the willingness to use and recombine existing information and resources into valuable opportunities" (Kibbeling et al., 2013). "In today's era, innovative companies use supply chain technology to deal with uncertainty and reduce costs, increase quality, achieve customer satisfaction, and gain competitive advantages and core competencies from competitors" (Jacques, 2012)."Innovation is essential for companies to improve performance and maintain competitive advantage in the supply chain" (Long, Feng, Fan, & Liu 2023). The ability to quickly build new business processes is a vital need for many firms in the twenty-first century in order to take advantage of constantly changing markets and technologies (Bernstein, et al., 1999). The majority of management watchers nowadays concur that successful 21st century

firms need to be able to keep creating new business procedures and methods of operation more quickly than before (Bernstein et al., 1999). A list often most recent studies along with their finding showing impact of cultural aspects on supply chain management is summarized in table 1.

Table 1: List of recent ten studies showing impact of cultural aspects on supply chain management

Authors	Findings
Zhou, Long, and Govindan (2024)	explore the role of top management support and organizational culture in socially sustainable supply chain management.
Zhang, Venkatesh, and Ohana (2024)	discuss the influence of normative institutions and individual cultural values on socially sustainable supply chain management.
Asif, Yang, and Hashim (2024)	investigate how digital transformation, corporate culture, and leadership enhance corporate sustainable performance in the Chinese manufacturing sector.
Tse and Pun (2024) Goh and Eldridge (2024)	analyze infrastructural capitalism in China, focusing on Alibaba's corporate culture and its three infrastructural mechanisms. study the mediating effects of five coordination mechanisms in sales and operations planning culture on supply chain performance.
Xiao and Khan (2024)	present empirical evidence on supply chain resilience and its impact on supply chain performance in the Chinese healthcare sector.
Song, Zhang, Shi, and Yin (2024)	examine the chain mediation analysis of intellectual capital and supply chain integration in the context of strategic human resource management.
Long, Feng, Fan, and	explore the moderating role of organizational culture in adopting blockchain technology to

Liu (2023)	enhance green supply chain integration.
Rizzi, Gigliotti, and Annunziata (2023)	provide insights into the role of supply chain integration in the nexus between GSCM and organizational culture.
Torgaloz, Acar, and Kuzey (2023)	analyze the effects of organizational learning culture and decentralization on supply chain collaboration during the COVID-19 period.

Supply Chain Technology Adoption, Supply Chain Management and Supply Chain Operational Performance: For the first 200 years, the word "technology" was referred to as 'useful arts' where "All tools, machines, utensils, weapons, instruments, dwellings, clothing, communication and transportation devices, and the skills by which we produce and use them" authors described technology. Dictionaries and academics have offered a plethora of technological insights through commonplace invention and revolution. Technology can be broadly defined as the branch of knowledge that deals with the invention and application of technical tools and their relationship with life, society, and the environment. It is based on fields such as industrial arts, engineering, applied sciences, and pure sciences (Li & Liu, 2023).

Supply chain technology started with information processing in the 1970s. Supply chain technology began to evolve in the 1980s with the establishment of sales data collection. In the 1990s, supply chain participants' work together to attain increasing levels of integration. Supply chain participants improved their skills in using supply chain technologies in the 2000s. The use of adopted technologies in supply chains has fundamentally changed in the twenty-first century, making full use of their capabilities whenever and wherever they are needed (Xia, Li, & He 2023). SCM tools or activities can be classified into three layers or areas, namely, Tools for supply chain cooperation, supply chain planning, and supply chain execution. "Sales and planning demand planning, sourcing, production, transportation, inventory and warehousing, and aggregate planning are all handled by supply chain planning software" (Zhou, Hu, Yu, Zhang, & Zheng 2024), on the other hand, claim that supply chain technology maybe methodically separated into four groups: software, e-commerce technologies, productivity and visibility, and process improvements. Additionally, Zhou, Hu, Yu, Zhang, and Zheng (2024) discovered that although certain supply chain technologies are externally focused, the majority of supply chain technologies are primarily internally focused. Every supply chain operation, however, uses a variety of supply chain technology tools, each with a different rationale than those found in the literature.

Technology adoption (table 2) in the supply chain has been seen as a complicated process, although there is a lot of room for its application in different value chain operations (Kauffman & Walden, 2001). The measurement of adoption and non-adoption has dominated much of the research on technology adoption in the supply chain (Ramayah et al., 2008; Wang, Yang, Qin, Yang, & Li 2023). The degree and richness of supply chain technology adoption are not entirely measured by this, despite the fact that it aids in understanding adoption decisions and adoption usage. Thus, by advancing to investigate the degree of use and utility of supply chain technology adoption, this study seeks to close the gap.

Table 2: Supply Chain Technology Adoption SCTA) evolution

1970s	**1980s**	**1990s**	**2000s**	**2010, onward**
Information	Scanner systems	Electronic Data Interchange (EDI)	"Supply Chain Management	Cloud Computing
Processing	Bar codes	E-Commerce	"Reinvention"	Mobile Supply Chain Management

				System
	Electronics	Vendor Management	"Warehouse Management Systems (WMS)"	
	Just in time (JIT)	Inventory Management	"Transportation Management Systems (TMS)"	
		Continuous replenishment system	"Customer Relationship Management (CRM)"	
		Direct store delivery	"Vendor Relationship Management (VRM)"	
		Computer assisted ordering	"Supply Chain Communication Systems"	
		Cross Docking	"Radio Frequency Identification (RFID)"	
			"Global Positioning Systems (GPS)"	
Adapted from (Collins et al. 2010; Chan and Chong 2013)				

The quality or usefulness connected with the applications of hardware and software components that are specifically employed in supply chain management (SCM) is known as supply chain technology utility. Shi, Zheng, Venkatesh, Humdan, and Paul (2023) found that opinions regarding the usage of SCM systems are significantly and favorably influenced by employees' perceived utility, based on 180 responses from workers who use the systems. Their research shown that it is feasible to utilize utility to gauge the uptake of supply chain technology, with the presumption that a favorable attitude toward its application will improve supply chain performance.

Studies provided evidence that those who find technology useful at work experience higher levels of productivity, effectiveness, and performance. Moreover, Fu, Liu, Tian, Peng, and Wu (2023) study included a thorough analysis of the benefits of e-commerce. The researchers discovered that users and non-adopters of various apps are highly discriminated against by the phrase "utility." The degree of usefulness is used, per the literature, to gauge supply chain technology adoption.

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