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Digital Technology Adoption for Building Supply Chain Resilience Amid the COVID-19 Pandemic: Evidence from South Korean Manufacturers

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ABSTRACT

This study examines the digital technology adoption of South Korean manufacturers amidst the pandemic unveiling how supply chain disruption orientation improves the adoption of technology to build supply chain resilience and market performance. This is an empirical study utilizing psychosomatic variables (supply chain disruption orientation, innovation adoption, digital infrastructure capability, supply chain resilience, and market performance) to build a model. A sample of 76 South Korean manufacturers is used to test the model and the interrelationships. PLS-SEM is employed for the analysis and mediation effects are provided. Findings indicate that supply chain disruption orientation was significant for the adoption of digital technology during the pandemic; moreover, digital technology facilitated improved supply chain resilience and market performance. Further implications are explicated in this paper.

Keywords: *digital technology, innovation adoption, market performance, supply chain disruption orientation, supply chain resilience*

1. INTRODUCTION

Supply chain disruptions occur frequently in today's changing business environment. The recent global pandemic and ensuing geopolitical events have highlighted the vulnerability of supply chains during these anomalies. While the topic of supply chain disturbances has recently gained much attention (Fan and Stevenson, 2018), the challenges of building resilient supply chains between suppliers and consumers have been an issue for quite some time (Tukamuhabwa *et al*., 2015). For example, Pournader, Kach, and Talluri (2020) examined the impact events such as globalization, network complexity, political turmoil, and natural disasters exert on the level of risk in a supply chain (Ivanov and Dolgui, 2020) and firm performance (Gölgeci and Ponomarov, 2015). Consequently, companies continue to face challenges to remain relevant during episodes of external market disruptions. Therefore, further studies measuring the antecedents of supply chain performance during disruptive events are warranted (Dubey *et al*., 2021).

In recent literature and throughout industry (Caputo *et al*., 2016; da Silva *et al*., 2018; Yang *et al*., 2021), the focus has shifted toward comprehending the impact of digital technologies on firm operations. In this regard, information technology (IT) has been found to enhance the information processing abilities of organizations (da Silva *et al*., 2018). Consequently, firms can compete efficiently in dynamic environments and simultaneously alleviate the effects of unforeseen disruptions in an effective manner (Gu *et al*., 2021). While the advancement of technology offers exciting prospects for companies, there still remains a lack of information regarding the implementation of digital infrastructures in the supply chains of organizations (Yang *et al*., 2021). The novelty surrounding the application of emerging digital technologies (e.g., big data analytics or artificial intelligence) in supply chain management makes it an exciting avenue to explore for supply chain researchers (Spieske and Birkel, 2021). Caputo *et al*. (2016) confirmed that the use of such innovations in production and supply chain management could benefit a firm greatly. Digital infrastructure proves to be a critical factor in a successful response to supply disruptions and unpredicted events (Wamba *et al*., 2020). Further, Spieske and Birkel (2021) commented that the development of robust digital infrastructure could fundamentally support innovation adoption and enhance supply chain resilience. In addressing the challenges posed by supply chain disruptions, this research composes a comprehensive investigation into the interplay between disruptive events, digital technologies, and the development of resilient digital infrastructure. By navigating this novel landscape, our study aims to provide valuable insights that contribute to the evolving discourse on supply chain management and supply chain resilience (Biedova and Mahdikhani, 2023).

A proactive approach to building the digital infrastructure of an organization is important when disruptive events occur. While acknowledging the evolving landscape of disruptions such as pandemics, our investigation reveals that a substantial number of companies are ill-prepared for these challenges (Ivanov, 2020). This highlights a critical research gap in understanding the implications of disruptive events on commercial supply chains, paving the way for our study to offer timely insights and strategic recommendations for businesses striving to enhance their resilience (Ivanov, 2020; Pournader *et al.*, 2020). Having established the pivotal role of digital technologies and resilient infrastructure in mitigating the impact of supply chain disruptions, the literature review that follows delves deeper into existing research. This exploration aims to contextualize our study within the current body of knowledge, identifying gaps and building a foundation for our research methodology and findings.

2. LITERATURE REVIEW

2.1 Theoretical Underpinning

2.1.1 Swiss Cheese Model

Risk remains a priority today amid heightened global dynamism that has been evident since the onset of the COVID-19 pandemic. With increasing uncertainty as a result of wars in Israel and Ukraine, it is likely that heightened dynamism will prevail. Firms must manage risk. Normal accident theory suggests that accidents happen as a normal part of operation (Perrow, 1994). Unfortunately, accidents and disruptions increase as operations and supply chains become increasingly more complex, as is the case today with the globalization of the supply chain (Chopra and Meindl, 2010; Perrow, 1994; Sagan, 1995). Reason (1977) describes a Swiss cheese model as a successful theoretical approach to alleviating the inevitable occurrence of such accidents where single tactics do not prevent all disruptions in a supply chain but may stop some incidences. In other words, it is necessary to adopt multiple preventative elements to build a high degree of resilience. In this case, digital technology is a source of several tactical options in the Swiss cheese model.

2.1.2 Resource-based View

Lately, most studies involving firm-level data analysis underpin the research model with the resource-based view or the dynamic capabilities framework. This paper follows the resource-based view where the firm and partners within the supply chain make up bundles of resources (Barney, 1991). Organizational culture and technology make up critical resources that build competitive success for a firm (Barney, 1991). Combined with the Swiss cheese model and the resource-based view the interrelationship model is further developed with a literature review.

2.2 Hypothesis Development

2.2.1 Supply chain disruption orientation

The recent pandemic and other disruptive occurrences around the globe have created a sustained period of indecision for corporations conducting commercial activities. These extraordinary proceedings have interrupted the operations and processes of many organizations. In supply chain management, disruptions can be classified as ambiguous situations that interpose on the regular flow of services or goods in a supply chain (Ambulkar *et al*., 2015; Gu *et al*., 2021). To reduce the impact of these disruptions, organizations are encouraged to discover novel systems and practices that will allow them to advance their operational efficiency (Bode *et al*., 2011; Craighead *et al*., 2020). This approach to managing supply network obstructions has been labeled supply chain disruption orientation (SCDO) (Bode *et al*., 2011). Acceptably, SCDO involves the meticulous analysis of diversionary scenarios to bolster approaches to moderate their negative effects (Reimann *et al*., 2017). To recover from supply chain disruptions, firms are willing to accelerate the use of IT systems to exploit the existing structured processes or explore unstructured processes (Andriopoulos and Lewis, 2009). This could be achieved in several ways. For example, an organization could employ new technologies to assist in procurement decision-making activities (Khan *et al*., 2019), or shape visual systems to assist in 'real-time' inventory controls or storage planning (Chen, Dui, and Zhang, 2020) when circumstances result in customer demand fluctuations (Hopkins and Hawking, 2018). In an analysis of firms in Malaysia for example, Khuan et. (2023) found that disruptions in supply chain led to inadequate data sharing and digital collaboration. The authors subsequently introduced several strategies that aimed to promote disruption orientation through applications such as the implementation of data interchange and investment into other emerging technologies (e.g., blockchain adoption) to enhance industry practices (Khuan et., 2023). In seminal research on the issue of disruption orientation, authors note the importance of SCDO exploration (Ambulkar *et al*., 2015). The advantages of aligning an organization with disruption orientation include operational efficiencies (Bode *et al*., 2011), knowledge acquisition to manage further disruptions (Reimann *et al*., 2017), partnership cultivation (Yang *et al*., 2021), competition mitigation (Chen *et al*., 2020), and strategy improvement (Ambulkar *et al*., 2015). Thus, the first two hypotheses are proposed:

H1*: Supply chain disruption orientation is positively associated with digital infrastructure capability.*
H2*: Supply chain disruption orientation is positively associated with innovation adoption.*

Organizations that strategically align themselves with SCDO principles exhibit a proactive stance toward exploring and understanding potential disruptions. This exploration (Ambulkar *et al*., 2015), goes beyond mere responsiveness and involves the meticulous analysis of diversionary scenarios to strengthen approaches for mitigating the negative effects of disruptions. An operational orientation that emphasizes the alleviation of derangements in firm distribution channels is pertinent. Dubey *et al*. (2021)

indicated that supply chain resilience could be thought of as a firm capability that would bridge the gap between a supply chain disruption and the amended performance of the supply chain. Furthermore, research by Ponomarov and Holcomb (2009) supports the notion that the development of systems to safeguard the supply chain against turmoil effectively establishes procedures that can be utilized to attain resilience. The link between disruption orientation and resilience is, therefore, grounded in the idea that the active efforts taken during disruptions contribute to the development of capabilities that aid in the recovery and restoration of normal operations. These aspects contribute to an organization's overall resilience, allowing it to adapt, respond, and recover effectively from unforeseen disruptions. Consequently, a third hypothesis is proposed:

***H3**: Supply chain disruption orientation is positively associated with supply chain resilience.*

2.2.2 Digital Infrastructure Capability

The introduction of technology-based sensory systems in operations provides value for firms (Hazen *et al*., 2016). The networking of interrelated devices (either through sensors, software, and other technologies) has been successfully applied in production process monitoring (Hopkins and Hawking, 2018), logistics tracking (Khan *et al*., 2019), and even in warehouse operations (da Silva *et al*., 2018). Other technologies related to big data analytics and artificial intelligence (AI) have achieved similar operational outcomes in supply chain processes and have enhanced business value (Hopkins and Hawking, 2018).

While research examining digital technologies has been relevant for some time, recently, there has been emergent interest in the adoption of these technologies at a supply chain level (Hazen *et al*., 2016). Experience seems to suggest that the adoption of digital infrastructure capabilities offers organizations several benefits. For example, the application of emerging digital technologies has been found to assist in the optimization of resource allocation (Ivanov *et al*., 2019), inventory management (Chen *et al*., 2020), customer forecasting (Nikolopoulos *et al*., 2020), and supplier selection (Ivanov and Dolgui, 2020). Firms utilizing digital technology seize the latest innovations to enhance key performance (Parast, 2020).

Previously, scholars argued that outdated information systems were insufficient in supporting effective supply chain resilience measures, especially following a major disruptive event (Pettit *et al*., 2019). These legacy systems generate human labor inefficiencies and fail to mitigate the risk of disruption. However, technological advancements have been made to counter the disruptive consequences of supply chain issues. Advances in emerging digital technologies progress autonomy and generate connections between products, processes, and machinery within and between firms (Ivanov *et al*., 2019). Thus, the fourth hypothesis is presented:

***H4**: Digital infrastructure capability is positively associated with supply chain resilience.*

In past research (Khan *et al*., 2019), there has been support for the importance of digital technologies in managing supply chain risk and uncertainty. According to the authors (Yu *et al*., 2018), organizations are able to use technologies to more effectively manage their supply chain ecosystems. For example, some technology processes such as product tracking (Khan *et al*., 2019) advance the robustness and transparency of the supply chain which enhances supply chain performance (Yu *et al*., 2018). Several papers (Drnevich and Crosson, 2013; Wang and Ahmed, 2007) show digital infrastructure capability positively impacts firm performance by enhancing flexibility and reducing costs related to the processes. Furthermore, as firms can collect valuable data via digital infrastructure, each function analyzes the market demand and trends to make better decisions (Martinez-Caro *et al*., 2020). These digital capabilities also reinforce the means necessary for firms to create opportunities that lead to competitive advantages (Heredia *et al*., 2022). Consequently, firms that obtain digital infrastructure capability develop market performance; therefore, the fifth hypothesis is proposed:

***H5**: Digital infrastructure capability is positively associated with market performance.*

2.2.3 Innovation Adoption

Supply chains are complex and dynamic in nature. This reality remains true in the current rapidly changing business environment. Accordingly, organizations are forced to introduce novel operations, processes, and systems in order to outperform their rivals (Ivanov and Dolgui, 2020). In supply chain management, the adoption of innovations in a data-driven world is advantageous for firms hoping to distribute value to customers and amplify competitive advantages (Bahrami, *et al*., 2022).

Several drivers of innovation adoption are postulated. Within an organization, innovations are adopted to consolidate firm operations (Bienhaus and Haddud, 2018) and cultivate strategic direction (Chavez *et al*., 2017). External drivers of innovation acceptance include the provision of products and services to meet customer needs (Chen *et al*., 2015), integrating network systems with supplier or supply chain partners (Florian and Abubaker, 2018), and instituting digital solutions to diminish supply chain costs thereby mitigating the impact of competition (Bahrami *et al*., 2022).

The application of innovations to strengthen supply chain resilience and produce competitive advantages has also been understood (Dubey *et al*., 2021). For many organizations, the confirmation of novel innovations could present further benefits. Chavez *et al*. (2017) noticed that some organizations were able to advance disruptive innovations following the adoption of digital technologies in their supply chain. For these companies, the advancement of digital strategies becomes an essential focus of their operations (Chavez *et al*., 2017; Florian and Abubaker, 2018).

Supply chain resilience obligates organizations to allocate operating resources in an effective way when handling supply chain concerns. Consequently, firms are assisted by technologies that are able to aid in the assignment of resources that can augment the supply chain. It is assumed that the proper adoption of IT was beneficial for generating supply chain resilience while researching 206 manufacturers in China during the pandemic of COVID-19. In past research (Yang *et al*., 2021), the adoption of certain innovations is shown to contribute to resource allocation and utilization (Ivanov and Dolgui, 2020). Accordingly, the strategic adoption of innovations positively influences supply chain resilience, emphasizing the pivotal role of innovation in navigating disruptions and optimizing resource utilization in dynamic supply chain environments. Therefore, the hypothesis of H6 is suggested as the following:

***H6**: Innovation adoption is positively associated with supply chain resilience.*

The adoption of innovations and other emerging technologies have been highlighted as processes that can intensify firm capacity and amplify organizational performance. The strategic embrace of innovations and emerging technologies stands out as a transformative process, not only enhancing firm capacity but also significantly amplifying overall organizational performance. By incorporating cutting-edge technologies, organizations fortify their ability to tackle challenges, adapt to evolving market dynamics, and ultimately achieve superior operational efficiency and effectiveness. Innovation adoption is linked to enhanced supply chain efficiency and responsiveness (Khan *et al*., 2019). In an examination of the application of big data analytics, Bahrami *et al*. (2022) distinguished that these capabilities cultivated supply chain performance by enabling decision-making, risk management, and forecasting procedures. In terms of systems innovation, innovation adoption strengthens firm performance as it increases the firm's effectiveness and efficiency (Siagian *et al*., 2021). Bahrami *et al*. (2022) indicated that an organization could leverage its acquired innovations to identify potential issues with supply chain disruptions and take measures to mitigate those risks. These steps could assist in supply chain operations becoming more robust and successful (Ivanov and Dolgui, 2020). Moreover, the strategic adoption of innovations extends beyond operational commands to encompass marketing and product innovations, imparting a positive effect on overall market performance. Ferreira *et al*. (2024) assert that integrating innovative practices in marketing and product development not only enhances market performance but also promotes a lasting competitive advantage for firms. This capacity to innovate and adapt in the marketing field contributes to the overall resilience and sustainability of the firm in the competitive landscape. Consequently, we propose the following hypothesis:

H7: *Innovation adoption is positively associated with market performance.*

2.2.4 Supply Chain Resilience

In a globalized world, supply chains are more complex and elaborate than ever before. As a result, they are also more problematic in nature. To manage this new reality, organizations are required to condition their supply chain to become more resilient. Sometimes referred to as supply chain resilience, this adaptive capability is characterized by a preparedness for unexpected events, while simultaneously being able to respond, and recover from disruptions caused by the impetuous situation (Chowdhury and Quaddus, 2017; Ponomarov and Holcomb, 2009). Thereby, a resilient supply chain is one that can adapt, quickly respond to, and recover from an unforeseen phenomenon, while also maintaining efficient organizational operations (Ambulkar *et al*., 2015; Ponomarov and Holcomb, 2009).

Supply chain resilience is a dynamic capability that contributes to the longevity of an organization (Yu *et al*., 2019). When a firm experiences a disruption, it deviates from the status quo. This divergence from routine operations can dominate the performance of organizations undesirably (Ivanov and Dolgui, 2020; Spieske and Birkel, 2021). Furthermore, it has been acknowledged that, through the application of both qualitative and quantitative research methods on a sample of 162 firms in China, that the enhancement of supply chain resilience significantly contributes to improved market performance (Xiao and Khan, 2024). However, organizations that are capable of recovering their operations and procedures to their pre-disruption levels quickly, are at an advantage (Chowdhury and Quaddus, 2017). It is proven that supply chain resilience brought to enhanced firm performance by statistically measuring 241 firms in China (Yu *et al*., 2019). Also, companies might even achieve competitive advantages if they can recuperate more successfully than rivals (Dubey *et al*., 2021). Thus, we assume the following hypothesis:

***H8**: Supply chain resilience is positively associated with market performance.*

2.2.5 Mediation Effects

An essential consideration of this study is to understand how the variables presented within can contribute to the overall performance of an organization (market performance). With regard to digital technologies, research has shown that firms invest large amounts of resources into the employment of digital technologies (Bahrami *et al*., 2022). However, on certain occasions, these technologies have failed to deliver value for the respective businesses (Ivanov, Dolgui, and Sokolov, 2019). Some authors (Correani *et al*., 2020) suggest that these failures occur when there is a discontinuation between the formulation and implementation of strategies (Arunachalam *et al*., 2018). These authors conclude that the unsuitable adoption of digital technologies may lead to undesirable outcomes for the firm. When innovations are deployed during periods of uncertainty, it could lead to higher risk and disruptions during the transformation phases (Spieske and Birkel, 2021). Ultimately, factors beyond the introduction of digital technologies play a role in their adoption and the success they will garner. As an example, Arunachalam *et al*. (2018) mentioned the impact digital technology adoption could stipulate on supply chain partners adjacent to a central firm. The integration of innovative practices could markedly shorten distribution times at one firm, but negatively impact other firms that are unable to manage environmental uncertainty (Arunachalam *et al*., 2018). A more holistic assessment of the factors leading to supply chain success in the context of digital technology adoption is therefore encouraged. The dynamic nature of supply chains therefore requires that this examination also investigate various interceding relationships between the study variables. It is assumed that these intervening relationships will greatly inform the research results. Consequently, additional mediating effects are presented in the following hypotheses:

***Hypothesis 9 (a, b)**: Digital infrastructure capability mediates the relationship between supply chain disruption orientation and supply chain resilience (H9-a); and between supply chain disruption orientation and market performance (H9-b).*
***Hypothesis 10 (a, b)**: Innovation adoption mediates the relationship between supply chain disruption orientation and supply chain resilience (H10-a); and between supply chain disruption orientation and market performance (H10-b).*
***Hypothesis 11 (a, b)**: Supply chain resilience mediates the relationship between supply chain disruption orientation and market performance (H11-a); between digital infrastructure capability and market performance (H11-b); and between innovation adoption and market performance (H11-c).*

Based on the above hypotheses, the conceptual model is presented in **Figure 1** and illustrates the relationships between the constructs of interest. As depicted in the model, the relationship between supply chain disruptions orientation, digital infrastructure capability, innovation adoption and supply chain resilience will be explored further. In addition, we argue that several of these constructs will impact market performance positively.

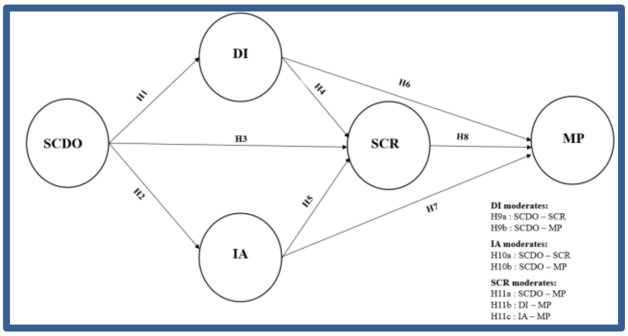

Figure 1 Structure of respondents according to the specialization of their enterprises in supply chains
Note: Supply chain disruption orientation (SCDO), digital infrastructure capability (DI), innovation adoption (IA), supply chain resilience (SCR), market performance (MP)

3. METHODOLOGY

3.1 PLS-SEM

This study involves psychosomatic items that represent variables and shape a research model to be tested quantitatively; moreover, structural equation modeling (SEM) is frequently employed for such models. Several methodological options have emerged for SEM analysis including covariance-based structural equation modeling (CB-SEM) and partial least squares structural equation modeling PLS-SEM. Both options have limitations and advantages. CB-SEM is restricted because it requires large sample sizes (200 – 300 respondents). Nevertheless, CB-SEM is advantageous as it returns universally recognized model fit numbers (Hair *et al*., 2021). PLS-SEM is valuable because it can successfully analyze models with smaller sample sizes yet PLS lacks universally recognized numbers for model fit. Given the widespread adoption of both methods in business research, it is reasonable to scrutinize sample size before selecting the analysis method (Hair *et al*., 2021). Here CB-SEM is not appropriate because of the small sample size of this study, a sample of fewer than 100 firms (Hair *et al*., 2021).

3.2 Sample

The sample for this research includes 76 industrial firms from South Korea (see **Table 1**). The survey was collected over two months (October – December 2020) amidst the disruptions stemming from the COVID-19 pandemic. A total of 200 firms were randomly sampled (emailed) from the Korean Chamber of Commerce; 76 responses were completely returned resulting in a 38% response rate. The majority of the respondents were managers (82.9%, 63 respondents) but included higher-level directors (9.2%, 7 respondents), and staff (7.9%, 6 respondents) as well. Most companies sampled (78.9%, 60 firms) had sales of fifty billion KRW or less. Another 14.5% (11 firms) had fifty to a hundred billion in sales while 6.6% (5 firms) had more than a hundred billion in sales. The firms were separated into three industry categories including automobile (50 firms, 65.8%), electronics (16 firms, 21.1%), and others (10 firms, 13.1%). Finally, firms were categorized by the adoption of digital supply chain management (SCM). A few of the sampled firms (8 firms, 10.5%) had no adoption of digital SCM. Most firms (56 firms, 73.7%) had used digital SCM for between 1 and 3 years while 12 (15.8%) had used it for more than 3 years.

Table 1 Demographics of the sample

Job Positions				
Interval	Staff	Manager	Over Director	Total
Count (%)	6 (7.9 %)	63 (82.9%)	7 (9.2%)	76 (100%)
Annual Sales				
Interval	KRW 50 bil. or less	KRW 50-100 bil.	Over KRW 101 bil.	Total
Count (%)	60 (78.9%)	11 (14.5%)	5 (6.6%)	76 (100%)
Industry				
Industry Type	Automobiles	Electronics and electrical	Others	Total
Count (%)	50 (65.8%)	16 (21.1%)	10 (13.1%)	76 (100%)
Operation of digital supply chain management				
Industry Type	No operation	1-3year	More than 3 years	Total
Count (%)	8 (10.5%)	56 (73.7%)	12 (15.8%)	76 (100%)

3.3 Research Instrument

The data collection instrument is a survey of psychosomatic questions that comprise variables and a research model. The survey included five variables and 15 psychosomatic questions in addition to demographic questions. The variables are based on previous literature and adapted for the South Korean supply chain management context; moreover, they were translated into Korean and translated back for precision. Each variable is further described in the following paragraphs.

Supply chain disruption orientation is a strategic orientation that emphasizes a firm's orientation toward managing supply chain interruptions as they occur. Yu *et al*. (2019) theorized that organizations that experience supply chain disruptions also develop a propensity to prepare for them. In this case, this strategic orientation is exhibited in several ways: management prepares for disruptions, the organization tries to maintain timelines, and communication lines between suppliers and customers are built (Bode *et al.*, 2011).

According to Singh and Singh (2019), digital infrastructure capability is the degree to which a firm relies on digital technology, in this case for the management of supply chain management. Here the practice of ERP, AI, or big data analytics indicates digital infrastructure (Singh and Singh, 2019). Additionally, digital infrastructure capability is quantified by the adoption of digital technology to review stock and visualize production volumes.

Innovation adoption refers to the degree to which firms adopt innovation for managing supply chain issues (Venkatesh *et al*., 2003). It is measured by the ease of management's discussion of and adoption of technology. Additionally, the attitude of employees and management regarding technology for building solutions is counted. Finally, the degree to which the firm pursues new technology is considered.

Table 2 Operationalization of the research instrument

Variable	Operational definition	Measurement items	Prior research
Supply Chain Disruption Orientation	The degree to which the organizational culture is focused on and prepared for supply chain disruptions.	〔SCDO1〕Everyone from management to employees are focused on disruptions and prepared for immediate fixes.	Bode *et al*. (2011); Yu *et al*. (2019)
		〔SCDO2〕The organization tries to set up and keep the timeline, in order to solve the disruption in the supply chain.	
		〔SCDO3〕The effective communication with customers is implemented by utilizing a core competence, in order to solve the disruption among supply chains.	
Digital Infrastructure Capability	The degree to which the firm relies on digital technology for supply chain management.	〔DI1〕The company operates SCM utilizing digital technology such as ERP, AI, or big data analytics.	Singh and Singh (2019)
		〔DI2〕Supply chain managers can review stock utilizing digital technology.	
		〔DI3〕Utilising digital technology managers are able to check the production volume daily/weekly/monthly.	
Innovation Adoption	The degree to which the firm adopts innovation as a solution to supply chain management issues.	〔IA1〕Within the company, it is easy to both discuss and get approved new technology for supply chain management.	Venkatesh *et al*. (2003)
		〔IA2〕There is a common understanding between management and employees that new technology will result in better performance.	
		〔IA3〕This company actively seeks new technology for supply chain management	
Market Performance	The degree to which this firm is able to perform well within the market.	〔OP1〕Our delivery performance has improved over the past three years because of supply chain management.	Carey *et al*. (2011)
		〔OP2〕Our stock has been appropriately managed over the past three years due to supply chain management.	
		〔OP3〕Supply chain management has helped our company to avoid a shutdown in the past three years.	
Supply Chain Resilience	The ability to avoid operational interruptions due to supply chain interruptions and/or recover rapidly from disruptions.	〔SCR1〕Through company agility, we are able to continue operations amid supply chain interruptions.	Golgeci and Ponomarov (2013); Wong *et al*. (2020); Yu *et al*. (2019)
		〔SCR2〕Exceptionally, this company is able to avoid operational shutdowns due to supply chain interruptions.	
		〔SCR3〕When shutdowns or interruptions occur, this company quickly recovers.	

Table 3 Outer model assessment

Variable	Factors	Standard load	AVE (AVE > 0.5)	Construct Reliability (C.R > 0.7)	Cronbach's Alpha (α > 0.6)
Supply Chain Disruption Orientation	SCDO1	0.740	0.694	0.871	0.780
	SCDO2	0.887			
	SCDO3	0.863			
Digital Infrastructure Capability	DI1	0.695	0.627	0.832	0.695
	DI2	0.917			
	DI3	0.746			
Innovation Adoption	IA1	0.893	0.769	0.909	0.848
	IA2	0.938			
	IA3	0.793			
Supply Chain Resilience	SCR1	0.860	0.688	0.868	0.771
	SCR2	0.880			
	SCR3	0.741			
Market Performance	MP1	0.870	0.622	0.831	0.694
	MP2	0.750			
	MP3	0.740			

Market performance is a measure of the capacity of the firm to provide market value to its customers even amid supply chain disruptions over the past three years (Carey *et al*., 2011). In this survey, items measure the ability of managers to sustain stock and improve SCM. Additionally, it should be assessed whether or not the firm has been able to avoid shutdowns.

Supply chain resilience is a measure of the ability of a firm to avoid, quickly recover from, or learn from shutdowns amid supply chain disruptions (Golgeci and Ponomarov, 2013; Wong *et al*., 2020; Yu *et al*. 2019). It is presumed that a company that displays resilience is agile in its operations. Additionally, it is remarked that a firm with resilience is able to avoid disruptions, unlike its competitors (Yu *et al*., 2019). Finally, a firm that exhibits resilience is able to recover quickly whenever shutdowns happen (Golgeci and Ponomarov, 2013). A detailed review of the measurement instruments can be found in **Table 2**.

4. ANALYSIS

4.1 Outer Model Assessment

This research was analyzed with SmartPLS 4.0 as with a sample size of 76 respondents it is the most appropriate SEM method of analysis. According to Hair *et al*., (2021), when the largest number of structural pathways directed at a construct is three, 10 times three is the number of respondents necessary to bring forth confirming results. Based on this reasoning, a sample of 76 respondents is more than twice the necessary sample size. When conducting a PLS-SEM analysis, researchers should assess the outer model (reliability and validity of the variables) before the inner model (interrelationships) (Hair *et al*. 2014; Nunnally and Bernstein, 1994). Multiple measures of reliability and validity exist; nevertheless, several standard statistics are scrutinized with PLS-SEM to authorize the various types of validity and reliability. Internal consistency reliability can be recognized through either Cronbach's alpha or composite reliability; here it is established with both statistics when values are above 0.7 (Hair *et al*., 2021). According to Hair *et al*. (2021), convergent validity can be confirmed when AVE values are above 0.5 as indicated in **Table 3**.

Discriminant validity can be noted in one of two statistical tests. Fornell and Larcker (1981) suggest that discriminant validity is certain when squared AVE scores are above corresponding correlation values as indicated in **Table 4**. Further, discriminant validity is complete when standard loadings are above 0.6. The strictest measure for discriminant validity is the Fornell-Larcker Criterion (Henseler *et al*., 2009); moreover, discriminant validity is well-established. It can be remarked that all standard measures of reliability and validity are extant.

Table 4 Fornell-larcker criterion

	DI	IA	MP	SCDO	SCR
DI	**0.792**				
IA	0.473	**0.877**			
MP	0.636	0.688	**0.789**		
SCDO	0.641	0.529	0.669	**0.833**	
SCR	0.638	0.590	0.766	0.708	**0.829**

IA: Innovation Adoption; SCR: Supply Chain Resilience; DI: Digital Infrastructure Capability; SCDO: Supply Chain Disruption Orientation; MP: Market Performance.

4.2 Inner Model Assessment

The inner model should be assessed once the outer model is complete. First, it is ordinary to scrutinize pathway coefficients with significance values. Significance is most frequently evaluated with the SmartPLS 4.0 bootstrapping method (Hair *et al*., 2021). In this study, the sample was bootstrapped to 2000 samples, and significance was assessed. All pathways were accepted with varying degrees of strength. Relationships can be interpreted as stronger when p-values are lower and coefficient values are higher.

The strongest relationship is found between SC disruption orientation and digital infrastructure capability (0.641***) followed by SC disruption orientation and innovation adoption (0.529***); moreover, this stipulates that an emphasis on disruptions leads to innovation adoption and digital technology use. The link between SC disruption orientation and SC resilience is also relatively strong (0.411***). According to the research model, SC resilience is further augmented, to a lesser extent by digital infrastructure (0.256**) and innovation adoption (0.252**). Additionally, market performance is strongly improved by SC resilience (0.446***) and innovation adoption (0.333***) but to a lesser extent by digital infrastructure capability (0.194**). Pathways can be reviewed in **Table 5** and are also displayed fully in **Figure 2.**

The structural model should be assessed through an analysis of the coefficient of determination (R2) and the cross-validated redundancy (Q2) as is exhibited in **Table 6**. The coefficient of determination suggests the explained variance described by the model. Market performance maintains the highest value (R2 = 0.681). Supply chain resilience (R2 = 0.587), digital infrastructure capability (R2 = 0.403), and innovation adoption (R2 = 0.270) also maintain strong values for explained variance. The cross-validated redundancy (Q2) is also quantified; moreover, any value above 0 is specified as acceptable with larger values more desirable. Values for cross-validated redundancy ascend from innovation adoption (Q2 = 0.192) through infrastructure capability (Q2 = 0.230), supply chain resilience (Q2 = 0.386), and market performance (Q2 = 0.411).

Table 6 Structural model assessment

Endogenous variables	R^2	Q^2
Innovation Adoption	0.270	0.192
Digital Infrastructure Capability	0.403	0.230
Supply Chain Resilience	0.587	0.386
Market Performance	0.681	0.411

Table 5 Pathway assessment

Hypotheses	Pathways	Pathway Coefficient	t-stats	p-value	Results
H1	SC Disruption Orientation → Digital Infrastructure Capability	0.641	8.242	0.000	**Accept**
H2	SC Disruption Orientation → Innovation Adoption	0.529	5.007	0.000	**Accept**
H3	SC Disruption Orientation → SC Resilience	0.411	3.118	0.001	**Accept**
H4	Digital Infrastructure Capability → SC Resilience	0.256	1.749	0.040	**Accept**
H5	Digital Infrastructure Capability→ Market performance	0.194	1.664	0.048	**Accept**
H6	Innovation Adoption → SC Resilience	0.252	2.207	0.014	**Accept**
H7	Innovation Adoption → Market Performance	0.333	3.790	0.000	**Accept**
H8	SC Resilience → Market Performance	0.446	3.469	0.000	**Accept**

SC refers to Supply Chain

Goodness-of-fit remains a contested statistic with regard to PLS-SEM analysis as no single number is universally prescribed despite several options emerging as proxies. We have adopted the measure suggested by Wetzels *et al*. (2009) as degrees of fit can be assessed. Accordingly, the square root of the AVE cut-off multiplied by the average R2 gives the goodness-of-fit value that can be compared by baseline values. The goodness-of-fit value of 0.492 indicates a large goodness-of-fit for this model, see **Table 7** for details.

Table 7 Goodness-of-fit

Description	Value	Baseline value	Reference
Goodness of Fit (GoF)	$\sqrt{\text{Cut} - \text{off of AVE X average of R\_}square}$ = $\sqrt{0.5\text{X } 0.485}$ = **0.492**	GoF *small* = 0.1 GoF *medium* = 0.25 GoF *large* = 0.36	Wetzels *et al*. (2009)

Table 8 Mediation effects of the sobel test

Mediating Pathways:	Mediation Effect (Z-value)	P-value
H9a: SC Disruption Orientation → **Digital Infrastructure Capability** → SC Resilience	1.715	0.043
H9b: SC Disruption Orientation → **Digital Infrastructure Capability** → Market Performance	4.266	0.000
H10a: SC Disruption Orientation → **Innovation Adoption** → SC Resilience	2.021	0.021
H10b: SC Disruption Orientation → **Innovation Adoption** → Market Performance	3.015	0.001
H11a: SC Disruption Orientation → **SC Resilience** → Market Performance	2.322	0.010
H11b: Digital Infrastructure Capability → **SC Resilience** → Market Performance	1.656	0.049
H11c: Innovation Adoption → **SC Resilience** → Market Performance	1.867	0.031

Mediating variables are in bold.

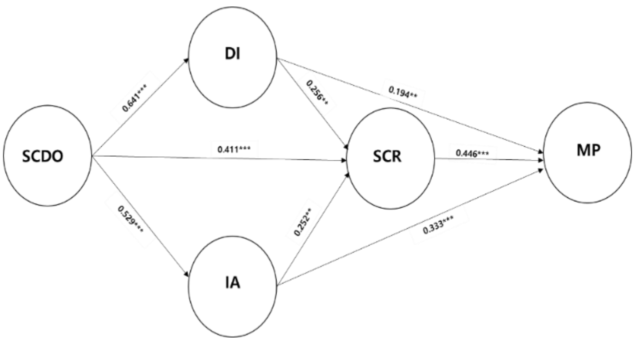

Figure 2 Results of the analysis

4.3 Inner Model Assessment

It is reasonable to test mediation effects as they can reveal indirect effects that pose additional meaning in a research model analysis. Several mediation methods have emerged; yet, the Sobel test remains the most frequently employed method for testing for mediation. In this case, mediation is indicated through a significance score and an examination of the Z-value. A higher score for the Z-value indicates stronger mediation. Additionally, a p-value indicates significance; a lower p-value indicates higher degrees of significance. All mediation tests are significant. A comprehensive review of the mediation effects is listed in **Table 8**.

5. DISCUSSION

In the context of supply chain disruption, our study investigates the profound impact of digital technology adoption on building supply chain resilience, particularly amid the challenges posed by the recent pandemic and other geopolitical events. The disruptions brought about underscore the critical need for organizations to fortify their supply chains against unforeseen shocks. From a practical perspective, the results of this study suggest that an investment in digital infrastructure has the potential to reward organizations with competitive advantages. Espousing digital infrastructure capabilities and supporting innovation adoption can engender supply chain resilience and market performance. Noteworthy, these relationships are evident amid increased dynamism caused by supply chain disruptions. Investing in technologies such as cloud computing, for instance, was found to enhance supply chain visibility and encourage data sharing, which can assist in efficient coordination among supply chain partners (Spieske and Birkel, 2021). Also, devoting resources to digital infrastructure can recover other supply chain functions such as scheduling or procurement (Arunachalam *et al*., 2018). Ultimately, digital advances to supply chain management can assist in the material and information flows of the company to build sustainable connections with suppliers and end-users (Bahrami *et al*., 2022).

When organizations invest in digital infrastructure, they are able to renovate their existing business models (Ivanov and Dolgui, 2020). The advancement of digital capabilities also augments the firm's value chain and potentially, the industry structure (Chen, *et al*., 2020). Several authors (Ivanov, *et al*., 2019) also confirm the value of digital infrastructure capabilities in supply chain operations (Ivanov and Dolgui, 2020). Digital technology venturing facilitates the management of supply chain relationships (Hopkins and Hawking, 2018), and also improves inventory systems (Hazen *et al*., 2016), resource allocation optimization (da Silva *et al*., 2018), and customer demand forecasting (Ambulkar *et al*., 2015). In other research (Pathak, 2023) digital technologies such as machine learning and artificial intelligence positively impacted the relationships between buyers and suppliers. Indeed, an investment in digital infrastructure appears to enhance supply chain resilience but most importantly, it also augments market performance. The link between investment in digital infrastructure and established market-based returns should ease supply chain manager concerns and encourage such investments.

For organizations, investment in digital technology can provide additional profits. Digitizing the supply chain produces immense amounts of data. In the digital age, this data becomes a new resource that has the potential to enhance firm competitiveness and potentially create value for the organization and its stakeholders (Yang *et al*., 2021).

Definitely, knowing that market performance can be advanced with such an investment is reassuring. With more information across departments, decisions can be executed with higher degrees of precision and accuracy. From a functional viewpoint, the adoption of digital technologies can assist firms in alleviating internal operational problems and therefore stimulate performance (Yang *et al*., 2021). Chavez *et al*. (2017) indicated that innovation adoption augmented organizational efficiencies related to procurement, production, and logistics; moreover, in a global and complex environment, the adoption of digital technologies also promoted the firm with cost-saving advantages.

Finally, given the effects presented between the constructs identified in the study, supply chain managers can strategically leverage digital technology adoption to navigate through and beyond the challenges posed by disruptions. From a practical perspective, firms should consider enhancing their decision-making abilities with data through an investment in technologies that enable real-time data collection and analysis. Companies can also implement data-driven decision-making processes to enhance precision and accuracy across departments. With regards to operational efficiency, firms are stimulated to employ innovation adoption practices. Here an organization can leverage digital technologies to alleviate internal operational challenges, fostering overall performance (Chavez *et al*., 2017). As a concluding remark, digital technologies encourage sustainable connections where firms can utilize digital advances in supply chain management to strengthen connections with all tiers of suppliers and their end-user base (Bahrami *et al*., 2022).

6. CONCLUSIONS

6.1 Contributions

To align with the focus of this research, this study emphasizes the transformative role of digital technology adoption in mitigating disruptions and building resilience. The discussion provides insights into the practical implications of our findings, offering concrete suggestions for supply chain managers to enhance their resilience strategies in the face of ongoing uncertainties. The adoption of innovations and the development of digital infrastructure capabilities present applications at various stages in the supply chain process. The deployment of these technologies profits an organization in areas such as product design (Chavez *et al*., 2017), procurement planning and decision-making (Yu *et al*., 2018), quality management (Spieske and Birkel, 2021), demand forecasting (Arunachalam *et al*., 2018), inventory control and planning (Bienhaus and Haddud, 2018), and even customer and supplier relationship management (Yu *et al*., 2019). The significance of research that is focused on digital technologies (and their adoption) is therefore worth further exploration (Yang, Fu, and Zhang, 2021). Accordingly, the current study aimed to provide further support for the importance of digital technology adoption in supply chain management.

6.2 Limitations and Future Research

The study outcomes can help managers recover supply chain and operations efficiency and effectiveness by making technology infrastructure adoption a value-creating approach. However, similar to previous research, this study had a number of limitations that may have impacted the findings. Firstly, this study was conducted in South Korea. Future studies should examine the model using data from other nations due to country-specific conditions. Second, our literature analysis is based on expert knowledge, but we could advance the validity of our framework by incorporating other methods in future research. Third, this data was acquired by a single participant from each organization. Further research is necessary, involving multiple participants and respondents from each organization. Finally, future research should include additional control variables, such as consumer buying habits, product evaluation, and environmental uncertainty.

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