

The Effect of Digital Supply Chain Technology on Supply Chain Resilience to Support Supply Chain Performance

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Abstract

Research Objectives: This research examines the effect of digital supply chain technology (DSCT) on supply chain resilience (SCR) and its impact on supply chain performance (SCP) in the context of the Industrial sector in Egypt. **Research Population:** The researcher used the simple random sampling method for a group of large-sized industrial companies that use digital technology in managing their supply chain. The researcher chose these companies because they were exposed to numerous disruptive events that affected their supply chain performance, necessitating support to enhance their supply chain resilience, particularly through digital supply chain technology. **Research Sample:** Stratified sampling is the most suitable for this research since the sample-choosing process relied on the characteristics needed for the sample to be random. In this study, the target respondents are personnel responsible for their company's supply chain or those in a higher position of control over the business operation. **Source of Collecting Primary Data:** The researcher used a survey questionnaire as one of the methods applied in collecting primary data. (Dalati & Marx Gómez, 2018). **Analysis Collecting Data:** Analysis and interpretation of the statistical data resulting from regression analysis and Structural Equation Modeling (SEM) using SPSS and AMOS programs. **Findings:** This research confirmed that there is a significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP), a significant effect of Digital Supply Chain Technology (DSCT) on Supply chain Resilience (SCR), a significant effect of Supply chain Resilience (SCR) on the Supply Chain Performance (SCP), in addition, Supply chain resilience (SCR) has a mediating role in the relationship between digital supply chain technology (DSCT) and supply chain performance (SCP). **Recommendations:** Digital supply chain technology and supply chain resilience become vital components for achieving a high performance of the supply chain. So it has become very important that

industrial companies invest in obtaining and applying digital supply chain technology and adopting and applying supply chain resilience principles. By using the tools of digital supply chain technology to enhance supply chain resilience, industrial companies can support and enhance their supply chain performance, therefore organizations can increase efficiency, reduce risks, and create a more sustainable future. Also, this research is recommended for further studies in other sectors like service companies, to study the effect of digital supply chain technology and supply chain resilience on other aspects of the supply chain like sustainability.

Keywords

Supply Chain, Supply Chain Resilience, Supply Chain Performance

1. Introduction

Organizations face severe challenges during turbulent situations, such as the COVID-19 pandemic. In this regard, there is a need to understand how technologies, including blockchain, additive manufacturing, and artificial intelligence, can help organizations effectively deal with these turbulent situations. There is a need to support capabilities through supply chain digitization to improve mechanisms for determining optimal inventory levels during the crisis. The most significant trends determined in the current research are the extensive use of Industry 4.0 elements and blockchain to transform the traditional supply chain into a digital supply chain (Ali, 2022).

Supply chain is a network that contains all stakeholders and activities involved in completing a customer's order, be it a product or a service. Supply chains include not just the suppliers and manufacturers, but any phase directly or indirectly involved, including transporters, distributors, retailers, and even end-customers. Further, these phases could be located in different countries across the world for a company with a global supply chain footprint (Srinivas et al., 2021). Supply chains become more complex networks as a manufacturer may source from multiple vendors and then supply to many distributors. Further, the flow can happen in both directions and may be controlled by one or more intermediate stages. Finally, through the whole process, along with the product, both information and funds constantly flow to make the supply chain efficient. Thus, most supply chains tend to be complex networks needing holistic management strategies to function effectively (Srinivas et al., 2021). According to Scholten and Fynes (2016) every firm is a part of at least one supply chain. Additionally, supply chains are the pathways that allow materials, services, and information to move from the initial provider to the final customer. Relationships between a company's supply chains and rising globalization have made it easier to conduct global operations, improve communication, and incorporate a wider range of products and more options for customers.

Supply chain management is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole (Haddouch et al., 2019).

Supply Chain management (SCM) can create value by operating better, faster, and cheaper than the competitors, also by creating value at each step in the supply chain; for example, from a global perspective, the ability to share information instantly and move products around the world cheaply (Stanton, 2023).

Risk management refers to the implementation of strategies and plans to manage supply chain networks through constant risk assessment and reduce vulnerabilities to ensure resilience in supply chains. All supply chains do not have the same risks, but some risks are common (Gurtu & Johny, 2021).

Risk factors include disruption in the transportation network, price fluctuation of raw materials, demand uncertainty, lead time and schedule delay, and Lack of knowledge about modern disruptive technologies (Karmaker et al., 2023).

Digitalization has changed the way people communicate and interact with their surroundings (Büyükoğkan & Göçer, 2018). There is hardly any aspect of life that has not been affected by digitalization, and supply chains are not an exception. New emerging digital technologies are paving the way toward more interconnected activities and a more transparent flow of information in the supply chain (Seyedghorban et al., 2020).

Kache and Seuring (2017) presented multiple opportunities of supply chain digitalization that include increased access to information, optimized logistics between companies in the supply chain, better supply chain visibility and transparency through real-time information access and control, efficient inventory management, increased end-to-end integration and connectivity in the supply chain. (Büyükoğkan & Göçer, 2018) stated that digitalization “enables the evolution of the next generation of supply chains offering both flexibility and efficiency.” They also claimed that a traditional supply chain consists of discrete, siloed steps, and by transforming a traditional supply chain into a digital supply chain, it is possible to achieve a fully integrated system that runs flawlessly (Büyükoğkan & Göçer, 2018). A Digital Supply Chain (DSC) refers to an intelligent, customer-centric, and data-driven network that leverages new approaches with innovative technologies and information systems to generate new forms of revenue and business value (Büyükoğkan & Göçer, 2018) and (Ageron et al., 2020).

In the face of the increasing vulnerability and complexity of the business environment, companies have started adopting the concept of resilience in their supply chains in order to handle disruptions. There are a few studies that have provided new insights into the impact of digital tools (DT) on Supply Chain Resilience (SCR).

(Papadopoulos et al., 2017; Ivanov, 2021; Dubey et al., 2019). Yao and Fabbe-Costes (2018) characterized SCR as a dynamic SC capability that is necessary when

dealing with an uncertain business environment. One key issue in operationalizing the concept of SCR is the way data are collected and analyzed (Ruel et al., 2013). Analyzed data can help make the right decisions in supply chain management and build the capabilities included in the SCR concepts like visibility, anticipation, and collaboration (Pettit et al., 2019). Digital tools can be useful in this context by implementing new digital tools, such as the Internet of Things (IoT), Big Data Analytics (BDA), Artificial Intelligence (AI), and so forth (Schoenherr & Speier-Perro, 2015; Büyüközkan & Göçer, 2018; Ivanov & Dolgui, 2019). Despite the growing adoption of digital tools, research on this topic has focused on the impact of a single digital tool on SCR (Papadopoulos et al., 2017; Dubey et al., 2019). However, when companies start to digitalize their SC, they may implement several digital tools at the same time (Frank et al., 2019). Recent studies have also examined supply chain resilience (SCR) and its influence on supply chain performance (SCP), and some have suggested that SCR is essential for managing vulnerabilities arising from numerous disruptions and risks (Chowdhury & Quaddus, 2017). Otherwise, those disruptions may immensely and adversely affect SCP (Pettit et al., 2019). Tukamuhabwa et al. (2015) and Pettit et al. (2019) recommended a wide range of supply chain management strategies, including increasing flexibility, creating redundancy, forming collaborative supply chain relationships, and thus improving SCR. These authors stated, through their extensive literature review of the theoretical foundations in this space, that only limited research has been conducted in choosing and implementing an appropriate set of strategies for improving SCR; Ali et al. (2017) defined these constructs for five core SCR capabilities: the ability to anticipate, to adapt, to respond, to recover, and to learn the phases of resilience, as well as discussed resilience strategies and capabilities that are necessary to be resilient. Other studies by Chowdhury and Quaddus (2017), Wieland and Wallenburg (2013) envisaged that SCR was a crucial factor influencing SCP.

Despite some encouraging first results on the interplay of SCR with some digital, Pettit et al. (2019) recommend further research. Addressing this gap in the literature is of utmost importance, as the emergence of new digital tools alters traditional ways of working and creates disruption across SC processes. However, the operating context in which SCR is likely to enhance the SCP of organizations has remained relatively under-researched. Owing to the strategic importance of SCR and SCP, it is of the utmost importance to understand the specific situations in which the relationship between SCR and SCP is highly effective. The study of Noman (2024) concluded that enhancing the supply chain resilience system can improve performance. Also, the study of Maharjan and Kato (2024) concluded that the implementation of logistics and supply chain resilience strategies (SCRESTs) aided companies in mitigating the adverse effects of disruptions, focusing on the case of the COVID-19 pandemic.

2. Literature Review

2.1. Digital Supply Chain Technology (DSCT)

In recent years, supply chains have experienced technological transformations

that require highly flexible and adaptable supply networks with structural variety and multi-functional processes (Kusiak 2020; Roeck et al., 2020; Ivanov, 2021). As a result, digital technology plays an increasingly important role in transformations in supply chains (Cai et al., 2021).

Supply chains have undergone technological changes recently that require highly flexible and adaptable supply networks with a variety of structural features and multi-functional processes (Kusiak, 2020; Roeck et al., 2020; Ivanov, 2021). As a result, digital technology plays a more important role in supply chain transformations (Cai et al., 2021).

Schrauf and Berttram (2016) stated that behind the huge potential of DSC is Industry 4.0, which is the fourth industrial revolution. Industry 4.0 has led to major improvements in different supply chain stages, including procurement, inventory management, logistics, production, and retailing, by facilitating process integration, automation, digitization, and analytical power. The ability to exchange data and make decisions is particularly useful in the supply chain as it has a dynamic network consisting of multiple stakeholders and stages needing collaborative decisions at every level (Srinivas et al., 2021).

Schrauf and Berttram (2016) asserted that, in addition to making the supply chain more valuable, digitalization might also alter it so that it offers services that are easier to access and more affordable.

According to Büyüközkan and Göçer (2018), the initial step towards DSC is digitalization. Digitalization is defined as the use of digital technology and the conversion of traditional businesses to digital enterprises, which results in the creation of new sources of income. Digital operations, digital organization and culture, and digital strategy might be considered the three key stages of digitalization (Corver & Elkhuizen, 2014). Worker empowerment, management, and execution of digital operations were prioritized in digitization operations. According to Frank et al. (2019), digital tools refer to technologies that provide intelligence and connectivity. Digital tools can be like the Internet of Things (IoT), Big Data Analytics (BDA), artificial intelligence (AI), radio-frequency identification (RFID), smart sensor technology, and so forth (Schoenherr & Speier-Pero, 2015; Büyüközkan & Göçer, 2018; Ivanov and Dolgui, 2019). When companies start to digitalize their SC, they may implement several digital tools at the same time (Frank et al., 2019). Emergent technologies, such as Big Data Analytics (BDA), blockchain, and Artificial Intelligence (AI), have accelerated the digitalization of supply chains (Dubey et al., 2020; Gawankar et al., 2020; Saberi et al., 2019; Song et al., 2021).

Ivanov and Dolgui (2019) researched and analyzed the effect of digitalization and Industry 4.0 on the ripple effect and disruption risk control analytics in supply chains. It was one of the first studies to detect the relationship between digitalization and supply chain risks. The stakes are now focused on SC digitalization in a business environment that is now more turbulent than ever (Ivanov & Dolgui, 2019), with financial, economic, ecological, and social risks. Of course, digitalization can be viewed as a solution to managing SC risks (Ivanov & Dolgui, 2019),

but the ongoing “wave” of digitalization also creates new dynamics that are often difficult to follow in companies (McKinsey study (Bughin et al. 2015); Deloitte, 2017), leading to new challenges for businesses and society.

In recent years, supply chains have experienced technological transformations that require highly flexible and adaptable supply networks with structural variety and multi-functional processes (Kusiak 2020, Roeck et al. 2020, Ivanov, 2021). Thus, digital technology plays an increasingly important role in supply chain transformations (Cai et al. 2021). Supply chains have undergone technological changes recently, which require highly flexible and adaptable supply networks with various structural features and multi-functional processes (Kusiak 2020, Roeck et al. 2020, Ivanov 2021). As a result, digital technology plays a crucial role in supply chain transformations (Cai et al. 2021). Ivanov and Dolgui (2019) proposed a 3D (three-dimensional) framework for analyzing the impacts of Industry 4.0 on supply chains. Their framework is composed of management, organizational, and technological perspectives. Büyüközkan & Göçer (2018, p. 165) define a Digital Supply Chain (DSC) as “an intelligent best-fit technological system based on the capability of massive data disposal and excellent cooperation and communication for digital hardware, software, and networks to support and synchronize interaction between organizations by making services more valuable, accessible and affordable with consistent, agile and effective outcomes”.

Barykin et al. (2021) define a DSC as the processes of modern supply chain require best digitalization practices, latest technologies, and technical solutions. The digital supply chain is the collective activities included in the supply chain process among the customers and suppliers connected through advanced technologies. The digital supply chain boosts data availability, interactions, collaboration, and information about the market. This information allows the firm to enhance the usefulness, productivity, and credibility of its products for the consumer (Büyüközkan & Göçer, 2018). Organizations worldwide attempt to give attention to the implementation of digitalization in production and supply chain management to get the best benefits for the firms. The digital supply chain has many benefits for firms, but many benefits are unused. There are many reasons for not exploiting the benefits of digitalization, such as upsetting the nature of the firm’s transformation or due to the negligence of managers (Büyüközkan & Göçer, 2018). Earning the benefits of the digital supply chain requires the integration of digital instruments and strategies that interconnect the consumer to the supplier and the entire body of workers with each other. There are two essential elements of the digital supply chain: one is digital transformation, and the second is the integration of smart technologies (Büyüközkan & Göçer, 2018). Some distinct characteristics are potentially associated with every DSC. Büyüközkan and Göçer (2018) list these factors as speed, flexibility, global connectivity, real-time inventory, intelligence, transparency, scalability, innovativeness, proactiveness, and eco-friendliness.

Stank et al. (2019) introduced a theoretically grounded digitally dominant

paradigm framework to help guide future SCM research. They argue that “seeing” (enhanced visibility), “thinking” (improved analytics), and “acting” (heightened operational flexibility and reduced cycle time) are essential elements of SC digitalization. The processes of a modern supply chain require the best digitalization practices, the latest technologies, and technical solutions (Barykin et al., 2021). Based on the previous definitions, the researcher proposes a definition of the Digital Supply Chain Technology as “A digital supply chain is a supply chain that takes advantage of digital technologies and data analytics to guide decision-making, optimize performance, and quickly respond to changing conditions”.

2.2. Supply Chain Resilience (SCR)

The concept of supply chain resilience gained attention in the early 2000s after the publication of seminal research by Christopher et al. (2004) and Sheffi and Rice Jr. (2005). At that time, resilience had already been well-studied in other fields, such as materials science and ecology. Over the past two decades, research on the use of redundancy and flexibility capabilities (such as risk inventories and backup suppliers) to improve supply chain resilience has advanced (Saghafian & van Oyen, 2016; Snyder et al., 2016; Pavlov et al., 2017; Lückner & Seifert, 2017; Yoo et al., 2020; Li et al., 2023).

The increasing interest in SCR is driven by globalization, technological changes, and increasing focus on efficiency in a turbulent business environment, exposing businesses to internal and external supply chain (SC) risks and disruptions (Ali et al., 2017). The following table provides a number of definitions of Supply Chain Resilience. The researcher proposes a definition of supply chain resilience as The ability of the supply chain to endure, adapt, or transform in the face of change and unexpected events. Christopher (2016) explains that a resilient SC must be able to identify the characteristics to adapt to an uncertain business environment: 1) Network-wide recognition of the most vulnerable parts of the SC; and 2) Recognition of the need to maintain a stock of strategic resources or excess capacity to be able to respond to sudden events. The review of the literature detects three important dimensions of SCR. First is supply chains’ preparedness, which is described as the readiness of a supply chain to face disruptions. It also involves the flexibility of supply chain operations to endure external and internal shocks. Moreover, by creating backup plans and establishing interest alignment among supply chain participants, a company can improve its supply chain preparedness. It equips a company to deal cooperatively with supply chain disruptions. Second is supply chain alertness, which refers to the ability of a supply chain to predict changes in the external business environment or from the internal supply chain network promptly (Kurtz & Varvakis, 2016). Third is supply chain agility, which represents the speed at which a supply chain confronts disruptions. Speed is a crucial component of supply chain agility.

2.3. Supply Chain Performance (SCP)

Performance is the measurement that a business uses to determine if a task or set of activities is accomplishing its/their objectives. Performance, in essence, measures the productivity and profitability of all tasks as well as their success or failure. Supply Chain Performance (SCP) is generally defined as the benefits derived from the efficiency and resilience of supply chain operations under a changing environment (Chowdhury et al., 2019). It reflects the extent to which the supply chain satisfies the end-customer needs in terms of product availability and on-time delivery while minimizing costs (Tarafdar & Qrunfleh, 2017). According to Khan et al. (2009), at the organizational level, SCP involves resource performance (efficiency), output performance (effectiveness), and flexibility performance (agility). Efficiency is the ability to create more value for the customers with less resource utilization; effectiveness is the ability to meet customer value, such as quality, cost, and delay; agility is the ability to maintain value creation in a turbulent and uncertain environment. SCP takes into account the operational status of the complete supply chain in addition to the performance of a single firm. Performance evaluation can assist businesses in reviewing their accomplishments, setting development objectives, and determining the course of future action (Gunasekaran et al., 2004).

Gunasekaran et al. (2004) believed that SCP measurement should not only include financial performance related to cost but also comprehensively cover non-financial indicators related to output. Previous studies on supply chain management have mainly adopted two different measures to evaluate SCP. The first measure is only related to costs, including inventory costs and operating costs (Chowdhury et al., 2019), whereas the second measure combines costs and customer needs in terms of quality, availability, and responsiveness. To manufacture and deliver the products to the end users, the supply chain's resource-gathering process is necessary (Alsuwaidi et al., 2021; Alzoubi & Yanamandra, 2020). There is a systematic technique for evaluating the effectiveness and efficiency of supply chain activities, according to Kaliani Sundram et al. (2016) and Ali (2022).

2.4 The Relationship between the Research Variables

2.4.1. Digital Supply Chain Technology (DSCT) and Supply Chain Performance (SCP)

The impact of digitalization in enhancing performance levels is revealed by existing studies. SCD can help in extensive supply chain integration and increase the degree of information sharing and data transparency of the entire supply chain to improve supply chain processes, such as procurement, production, and inventory management, and ultimately improve the performance level (Bai et al., 2020; Factorachian & Kazemi, 2021).

SCD can enhance supply chain visibility, connectivity, innovation, real-time transparency, speed, and other factors, allowing related organizations in the supply chain to better allocate resources and build capabilities to meet the different

needs of the consumers (Culot et al., 2020; Frank et al., 2019). Saryatmo and Sukhotu (2021) also concluded that the digital supply chain can improve product quality and productivity while reducing production costs, thereby improving supply chain operations. Digitalization in manufacturing can hasten business innovation, improve resource efficiency and cost savings, and support sustainable supply chains (Rossit et al., 2019; Haseeb et al., 2019).

The DSC will integrate innovative technologies (e.g., augmented reality, Big Data analytics, Blockchain), focus on customers/consumers, reduce internal organizational costs, and create more value for organizations.

Ben-Daya et al. (2019) and Majeed and Rupasinghe (2017) have explored the role of the Internet of Things (IoT) in facilitating planning, control, and coordination processes of the supply chain and in supporting Industry 4.0 and DSC.

Preindl et al. (2020) have focused on the impact of Industry 4.0 and Digital Transformation on information sharing and decision-making across the whole supply chain. Makris et al. (2019) have examined how multinational companies from five different industries can adapt to Supply Chain 4.0 to gain a competitive advantage from this transition. Other studies have explored how Big Data Analytics (BDA) and predictive analytics enhance supply chain performance by improving visibility, robustness, resilience, and organizational performance. As in the case of the digital technologies already mentioned, the use of cloud computing within the supply chain also remains little explored in theory and practice. The few empirical works investigating this issue have focused on the factors influencing the adoption of cloud computing (Wu et al., 2013; Moyano-Fuentes et al., 2019), and the impact of Cloud computing on the supply chain (Jede & Teuteberg, 2015). The studies show that cloud computing contributes to the development of supply networks and to the efficiency and responsiveness of supply chain processes (Jede & Teuteberg, 2015). Therefore, we argue that:

H1: There is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP).

2.4.2. Digital Supply Chain Technology (DSCT) and Supply Chain Resilience (SCR)

Hald and Coslugeanu (2022) identify four critical resilience capabilities that digital technologies can enhance. They include flexibility, visibility, risk management, and collaboration. Tseng et al. (2022) suggest that digital platforms can help companies gain timely insight into consumer demand, alter sales processes and channels flexibly, and secure business continuity during disruptions. Zouari et al. (2021) investigated the link between supply chain resilience (SCR) and supply chain digitalization (SCD), and they found that SCR is positively impacted by both the degree of digital maturity and the adoption of digital tools. Ivanov (2021) developed conceptual guidelines for digital supply chain management and the use of technology to enhance resilience by building and using end-to-end visibility in pandemic conditions. He extended the analysis of digital technology applications to supply chain resilience from instantaneous, single-event disruptions to pan-

demographic settings using the COVID-19 example. Through this effort, he offered novel insights into how to help firms prepare their supply chains for possible future pandemics or severe pandemic-like crises. He stressed that end-to-end visibility can help improve supply chain resilience in an efficient manner without building excessive and expensive redundancies. He provided a comprehensive taxonomy of crucial problem areas during the pandemic and associated solutions from digital technology. [Ivanov and Dolgui \(2019\)](#) considered the impact of digitalization on the resilience of operations and SCs as a complex issue. They highlighted the value of the descriptive and predictive use of data analysis in gaining visibility and better forecast accuracy, as well as improving the activation of contingency plans. In the same vein, [Zhang and Zhao \(2019\)](#) showed that big data analysis enhances SCR by improving visibility. Cloud computing and blockchain technology improved visibility, anticipation, and adaptability, which can foster SCR ([Pettit et al., 2019](#)). [Singh and Singh \(2019\)](#) research results showed that prior firm experience in dealing with supply chain disruption events did not translate into future disruption mitigation capabilities. However, if the organization develops BDA capabilities (big data analytics as digital tools), it positively impacts a firm's ability to harness its resident knowledge to mitigate future supply chain disruption events. The results also highlight the significant role played by BDA capabilities in enhancing the impact of ITICs (information technology infrastructure capabilities) on organizational ability to manage supply chain-related business disruption. The paper concluded with the recommendation that, for firms to develop effective supply chain risk mitigation capabilities, it is necessary for them to focus on developing BDA capabilities within their organization. [Singh and Singh \(2019\)](#) their analysis reveals two significant findings. First, the authors observed that institutional experience with managing supply chain disruption events had a negative impact on firm's ability to develop business risk resilience. However, if the organizations adopt BDA capabilities, they enable them to effectively utilize resident firm knowledge and develop supply chain risk resilience capacity. The results further suggested that BDA positively adds to an organization's existing IT capabilities. The analysis showed that BDA mediates the impact of ITICs (information technology infrastructure capabilities) on the organization's ability to develop risk resilience to supply chain disruption events. Therefore, we argue that:

H2: There is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Resilience (SCR).

2.4.3. Supply Chain Resilience (SCR) and Supply Chain Performance (SCP)

Past literature widely demonstrated that supply chain performance (SCP) and its antecedents, SCR and SCI critical drivers of organizational and market performance. There were also calls for more exploration of how digitalization can lead to SCP improvement in crisis scenarios ([Pettit et al., 2019](#); [Zouari et al., 2021](#)). [Gu et al. \(2021\)](#) examined how firms implement different information technology (IT) patterns (exploitative versus explorative) with SC partners to achieve supplier

and customer resilience from information processing theory and examined the performance implications of these two dimensions of SC resilience. In addition, this study also investigates how IT ambidexterity reconciles the paradox between IT exploitation and IT exploration in enhancing SC resilience. The results showed that both supplier and customer resilience could improve SC performance. To achieve the two aspects of SC resilience, only the explorative use of IT with suppliers and customers had significant effects. The results also showed that the ambidextrous use of IT on the customer side took effect. The exploitative and explorative use of IT complemented each other to improve customer resilience. The findings of this study contributed to IT and SC resilience literature. Therefore, we argue that:

H3: There is a statistically significant effect of Supply Chain Resilience (SCR) on Supply Chain Performance (SCP).

2.4.4. The Mediation Effect of Supply Chain Resilience (SCR) on the Relationship between Digital Supply Chain Technology (DSCT) and Supply Chain Performance (SCP)

Improvements in process efficiency can have a direct impact on supply chain performance (SCP), and in a changeable environment, digitalization can strengthen SCR's dynamic capability, allowing businesses to perform better and maintain a competitive edge. Zhao et al. (2023) stated that SCD during a crisis could improve SCR capability (three capabilities: "absorptive, response, and recovery"), thus achieving a better SCP. This study also offered practical suggestions for business managers on how to strategically create digital and resilient supply networks to deal with highly vague market conditions. SCR, as a special supply chain dynamic capability, plays a mediating role between SCD and SCP (Belhadi et al., 2021).

The integration of digital technologies with the existing supply chain processes of organizations can improve data visibility, enable digital business processes such as digital product design and manufacturing, enhance operational efficiency, and reduce production costs, which can have a positive impact on SCP (Hald & Coslugeanu, 2022; Holmström et al., 2019; Ivanov, 2021).

Belhadi et al. (2021) declared that a digitalized supply chain can promote supply chain visibility and enable flexible adjustment of structure, organization, and capabilities, improve product quality, and enhance supply chain efficiency while helping the supply chain achieve resilience. Also, the increased visibility caused by digitalization facilitates risk perception and resource preparation and enhances absorptive capability (Ivanov & Dolgui, 2019). Taking into account the advantages of digitalization, scholars have started to investigate how supply chain digitalization (SCD) can help companies improve supply chain resilience (SCR) in crises, enabling them to recover quickly from disruptions to their original performance levels (Büyükoğkan & Göçer, 2018; Stank et al., 2019; Hennelly et al., 2020). Bahrami et al. (2022). Their findings demonstrated that BDA (Big Data Analytics) capabilities had an important and positive effect on SC resilience, SC innovation, and SC performance, with SC resilience and SC innovation identified as substan-

tial mediators. The main findings of this study revealed that BDA capability can be a strategic investment in improving SC performance. Also, companies should invest in SC resilience and SC innovation development supported by BDA capabilities since they are strong mediators between BDA capabilities and SC performance. Belhadi et al. (2021) demonstrated that AI (Artificial Intelligence) information processing capabilities significantly influence SCP directly by enhancing related metrics or creating long-lasting SCP through SCR building. Notably, developing a sustained SCP requires firms to develop AI capabilities to enhance SCR through its principal AC (Adaptive Capabilities) enablers and SCC (Supply Chain Collaboration) under the dynamism and uncertainty of the supply chain environment. Therefore, we argue that:

H4: Supply Chain Resilience (SCR) has a mediating role in the relationship between Digital Supply Chain Technology (DSCT) and Supply Chain Performance (SCP) (Figure 1).

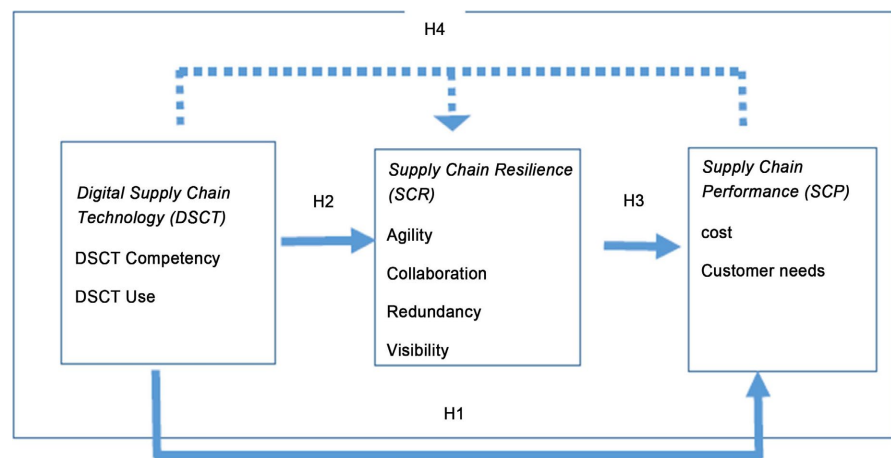


Figure 1. The conceptual framework, which presents the hypothesized relationships among the research variables forming the basis of the study hypotheses.

3. Research Methodology

3.1. Research Purpose

Saunders et al. (2016) classified the research purpose into three categories: Exploratory, Descriptive, Explanatory, and Evaluative purposes. Exploratory research is the initial research into a hypothetical or theoretical idea in which a researcher has an idea or has observed something and attempts to understand more about it. Explanatory study has a valuable research purpose that asks open questions to discover what is happening or obtain insights about a topic of interest. Research questions begin with 'What' or 'How'. The questions asked during data collection to explore a phenomenon, issue, or problem are also expected to start with 'What' or 'How'. An exploratory study will be valuable if the researcher clarifies the understanding of a phenomenon, issue, or problem, such as if the researcher is unsure of its exact nature. In Descriptive research, the researcher is aware of the phe-

nomenon before collecting data. The purpose of descriptive research is to gain a precise profile of situations, events, or persons. Descriptive research questions begin with or include either 'Who', 'what', 'Where', 'When', or 'How'. Questions that you ask during data collection to gain a description of events, situations, or persons will also be liable to start with, or include, 'Who', 'What', 'Where', 'When', or 'How'. Explanatory research is when a researcher seeks to study a problem to establish a causal connection between variables. Studies that establish causal relationships between variables may be termed Explanatory Research. Research questions that seek explanatory answers could begin with, or include, 'Why' or 'How'. Questions that researchers ask during data collection to gain an explanatory response would also possibly start with, or include, 'Why' or 'How'. The purpose of Evaluative research is to find out how well something works. Research questions seeking to evaluate answers begin with 'How', or include 'What', in the form of 'To what extent'. Evaluative research in business and management is expected to be concerned with assessing the effectiveness of an organizational or business strategy, initiative, policy, process, or program. This may relate to any area of the organization or business, e.g., the delivery of a support service, evaluating a personnel policy, a costing strategy, or a marketing campaign (Saunders et al., 2016). According to the purpose and objectives of this study, it examines the direct effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP) and indirectly through Supply chain Resilience (SCR) as a mediating variable. This research follows the Explanatory method since it attempts to identify the effects of the variables under investigation and the relationships between them.

3.2. Research Design

Research designs can be classified into three categories: Qualitative, Quantitative, and mixed methods. The qualitative method uses assumptions to build theories deductively, building protections against bias and how to generalize and duplicate findings. This method works with small samples of people studied in-depth in their natural situation. The quantitative method is often independent in the context of the study, and it targets large numbers of context-stripped data to look for statistical significance. The mixed-method approach combines both qualitative and quantitative data. It examines both methods together to answer the research question. Researchers could interview experts, sort them out into groups, and compare and evaluate the test scores into different groups (Guetterman et al., 2019; Saunders et al. 2016) discussed the methodological choice of quantitative, qualitative, or mixed-method research design. The authors clarify the three methods. Quantitative research examines relationships between variables, measures numerically, and analyzes using a range of statistical and graphical techniques. Qualitative research is often associated with an interpretive philosophy. It is interpretive since researchers need to make sense of the subjective and socially constructed meanings expressed about the phenomenon being studied. A qualitative research design may use a single data collection technique, such as semi-structured interviews or a corresponding qualitative analytical procedure. Mixed meth-

ods research is the branch of multiple methods research that combines quantitative and qualitative data collection techniques and analytical procedures. This research follows the Quantitative Method, which evaluates the direct effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP) and indirectly through Supply Chain Resilience (SCR) as a mediating variable in the context of Egyptian industrial companies.

3.3. Research Approach

Bryman and Bell (2011) discussed two main research approaches: inductive and deductive. A deductive approach is applied if the research starts with a theory based on previous studies in the literature review, and the research strategy verifies that theory. An inductive approach begins the research by collecting data to explore a phenomenon, and hence, theories are built, usually by providing a conceptual framework. This research follows the deductive approach as it started with an existing theory based on a systematic literature review for the relationships between Digital Supply Chain Technology (DSCT), Supply Chain Resilience (SCR), and Supply Chain Performance (SCP). Then, hypotheses were formulated based on the interviews with experts in logistics and supply chain fields, and data were collected from Egyptian industrial companies to examine these hypotheses of the relationship between the independent variable digital supply chain technology (DSCT), mediator variable supply chain resilience (SCR), and the dependent variable supply chain performance (SCP).

3.4. Research Population

The researcher used the simple random sampling method for a group of large-sized industrial companies that use digital technology in managing their supply chain. The researcher chose these companies because they were exposed to many disruptive events that affected the performance of their supply chains, which required support to enhance their supply chain resilience, especially with the use of digital supply chain technology.

3.5. Research Sample

The stratified sampling is the most suitable for this research since the sample-choosing process relied on the characteristics needed for the sample to be random. In this study, the target respondents are personnel responsible for their company's supply chain or those in a higher position of control over the business operation.

3.6. Sample Size Determination

As there were many limitations that prevent access to the entire study community, including the large size of the study community, time, and cost, the researcher relied on the sampling method to collect preliminary data. The researcher relied on the random class sample method in selecting those who are responsible for a company's supply chain or those in a higher position of control over the business

operation.

To determine the sample size, the researcher used the following equation to estimate the sample size:

$$n = \frac{P(1-P)}{\frac{(e)^2}{(Z)^2}}$$

whereas:

(*n*) Sample size

(*Z*) The standard value, which is statistically = (1.96) at a significant level of (0.05)

(*P*) The percentage of availability of the main phenomenon under study, which is equal to (50%).

(1 – *P*) The percentage of non-availability of the main phenomenon under study, which is equal to (50%).

(*e*) The sampling error, which is equal to (0.05)

According to the previous equation, the sample size can be calculated as follows:

$$\text{sample size} = \frac{0.5 \times 0.5}{\frac{(0.05)^2}{(1.96)^2}} = 384$$

Therefore, the minimum sample size is 387.

3.7. Data Collection

For the purpose of this study, and according to the research aim and objectives, the researcher followed a quantitative approach to measure the research variables. Thus, a survey questionnaire was used for data collection. The questionnaire consisted of 3 sections. Section 1 is related to Digital Supply Chain Technology (DSCT), Section 2 is related to Supply Chain Resilience (SCR), and finally, Section 3 is related to Supply Chain Performance (SCP). The respondents were requested to tick the five-point Likert scale. This scale has widespread use and requires respondents to determine the level of agreement through a series of statements regarding this study. The questionnaire provided closed-ended questions on an online platform using the Google Form application. The questionnaire was judged by presenting it to some university professors as well as some industry experts. The study community is the Egyptian companies in the industrial sector, and the researcher used the records that were provided by the Federation of Egyptian Industries “FEI”, Industrial Modernization Center “IMC”, and the Industrial Development Authority “IDA” to determine which companies can be added to the sample. Stratified sampling is the most suitable for this research since the sample-choosing process relied on the characteristics needed for the sample to be random. In this study, the target respondents are personnel responsible for their company’s supply chain or those in a higher position of control over the business operation. The researcher distributed the questionnaires to the study sample. All received

questionnaires were separately examined to test their reliability and validity for the statistical analysis, and the invalid ones were excluded. 420 questionnaires were distributed, and the questionnaires that were valid for analysis were 402 forms, i.e., 95.7% of the 420 distributed questionnaires.

4. Discussing Inferential Statistics

1) The First Hypothesis Test

There is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP).

To test this hypothesis, the researcher used a simple linear regression and obtained the following results:

Parameter	B	T. Test		F. test		R ²
		Value	Sig.	Value	Sig.	
Constant	2.817	15.773	0.000			
Digital Supply Chain Technology (DSCT)	0.292	5.869	0.000	34.440	0.000	0.79

Source: Prepared by the researcher according to the Statistical Analysis Results.

From the previous table:

- The independent variable Digital Supply Chain Technology (DSCT) is significant and has an effect because the level of significance is less than 0.05 (sig > 0.05).
- The coefficient of R-square equals 79%; this is the percentage of the effect of the independent variable Digital Supply Chain Technology (DSCT) on the dependent variable Supply Chain Performance (SCP), and the rest of the percentage is due to random error or may be due to other independent variables not included in the model.
- According to the previous results, we accept the Hypothesis, which means there is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP).
- This is consistent with the previous literature, such as the study of [Lee et al. \(2022\)](#), which established that the DSC positively affected supply chain performance, and the studies of [Srivastava & Sushil \(2013\)](#); [Alicke et al. \(2017\)](#), and the study of [Lee et al. \(2022\)](#). These studies discovered a positive relationship between digital supply chains and supply chain performance. Supply Chain digitalization has significant agility and flexibility to generate supply chain capability. Flexibility and agility in the Supply Chain have a distinct ability to deal with the high uncertainty of market conditions. Simultaneously, through implementing digital supply chain technology, companies can use online delivery channels, which can help them create additional revenue opportunities. At the same time, the digital supply chain can provide effective channels to facilitate end-to-end connectivity with supply chain partners, which can create

an open system and improve the long-term profitability of the company.

2) The Second Hypothesis Test

There is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Resilience (SCR)

To test this hypothesis, the researcher used a simple linear regression and obtained the following results:

Parameter	B	T. Test		F. Test		R ²
		Value	Sig.	Value	Sig.	
Constant	1.330	8.273	0.000			
Digital Supply Chain Technology (DSCT)	0.683	15.900	0.000	252.807	0.000	0.402

Source: Prepared by the researcher according to the Statistical Analysis Results.

From the previous table:

- The independent variable Digital Supply Chain Technology (DSCT) is significant and has an effect because the level of significance is less than 0.05 (sig > 0.05).
- The coefficient of R-square equals 40.2% this is the percentage of the effect of the independent variable Digital Supply Chain Technology (DSCT) on the mediator variable Supply Chain Resilience (SCR), and the rest of the percentage is due to random error or may be due to other independent variables not included in the Model.
- According to the previous results, we accept the Hypothesis, which means there is a statistically significant effect of Digital Supply Chain Technology (DSCT) on Supply Chain Resilience (SCR).
- This is consistent with the previous studies of [Zouari et al. \(2021\)](#), which investigated the link between SCR and SC digitalization, and they found that SCR was positively impacted by both the degree of digital maturity and the adoption of digital tools. Also, the study of [Ivanov \(2021\)](#) developed conceptual guidelines for digital supply chain management and the use of technology to enhance resilience by building and using end-to-end visibility in pandemic conditions; he extended the analysis of digital technology applications to supply chain resilience from instantaneous, single-event disruptions to pandemic settings using the COVID-19 example. Through this effort, he offered new insights into how to help firms prepare their supply chains for possible future pandemics or severe pandemic-like crises. He has stressed that end-to-end visibility can help improve supply chain resilience in an efficient manner without building excessive and expensive redundancies. He provided a comprehensive taxonomy of crucial problem areas during the pandemic and associated solutions from digital technology. Also, the study of [Ivanov and Dolgui \(2019\)](#) considered the impact of digitalization on the resilience of operations and SCs

as a complex issue. They highlighted the value of the descriptive and predictive use of data analysis in gaining visibility and better forecast accuracy, as well as improving the activation of contingency plans. In the same manner, [Zhang and Zhao \(2019\)](#) show that big data enhances SCR by improving visibility. Cloud computing and blockchain technology improve visibility, anticipation, and adaptability, which can foster SCR ([Pettit et al., 2019](#)).

3) The Third Hypothesis Test

There is a statistically significant effect of Supply chain Resilience (SCR) on Supply Chain Performance (SCP)

- To test this hypothesis, the researcher used simple linear regression and obtained the following results:

Parameter	B	T. Test		F. Test		R ²
		Value	Sig.	Value	Sig.	
Constant	1.330	8.273	0.000			
(Supply Chain Performance)	0.683	15.900	0.000	252.807	0.000	0.387

From the previous table:

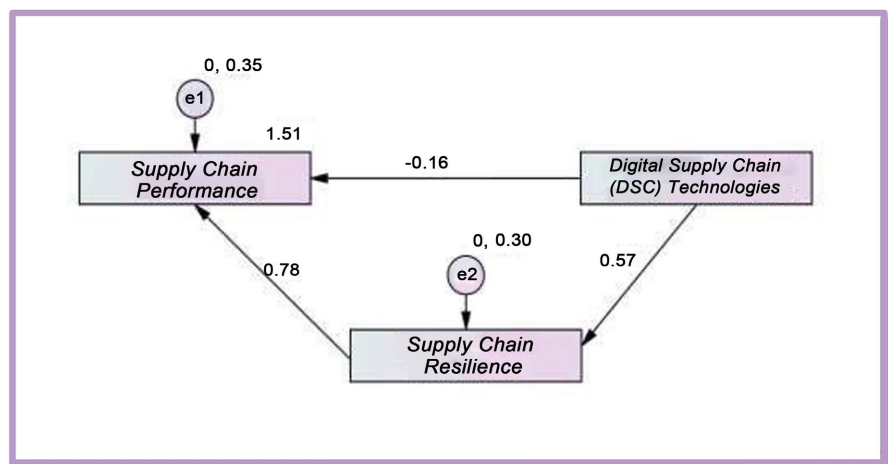
- The independent variable Supply chain Resilience (SCR) is significant and has an effect because the level of significance is less than 0.05 (sig > 0.05).
- The coefficient of R-square is equal to 38.7%; this is the percentage of the effect of the mediator variable Supply Chain Resilience (SCR) on the dependent variable Supply Chain Performance (SCP), and the rest of the percentage is due to random error or may be due to other independent variables not included in the model.
- According to the previous results, we accept the Hypothesis, which means there is a statistically significant effect of Supply Chain Resilience (SCR) on Supply Chain Performance (SCP).
- This is consistent with the previous studies of [Chowdhury and Quaddus \(2017\)](#) and [Sheffi and Rice Jr. \(2005\)](#) showed that while response and recovery capability had a significant positive influence on SCP, response and recovery capability reflected the ability of the supply chain to respond in time, allocate resources reasonably, recover quickly, and achieve better business conditions when the risk occurs. In addition, the study of [Tukamuhabwa et al. \(2015\)](#) also showed that the more responsive and resilient the supply chain was, the less liable the supply chain would suffer from disruption loss, which will have a positive impact on SCP.

4) The Fourth Hypothesis Test

Supply Chain Resilience (SCR) has a mediating role in the relationship between Digital Supply Chain Technology (DSCT) and Supply Chain Perfor-

mance (SCP)

- To test this hypothesis, the researcher used the path analysis method, where he built the appropriate causal model for application in this study, which is the mediation model, which consists of three types of variables that reflect the relationship between the independent variable and the variables affected by it.
- The Independent Variable: Digital Supply Chain Technology (DSCT) is symbolized by (X).
- The Dependent Variable: Supply Chain Performance (SCP) is symbolized by (Y).
- Mediator variable: Supply chain Resilience (SCR) which is the variable through which the influence of the independent variable is transmitted to the dependent variable, and it is symbolized by the symbol (Z).



Source: prepared by the researcher according to the Statistical Analysis Results.

The previous figure shows the following:

- The direct impact of Digital Supply Chain Technology (DSCT) on Supply Chain Resilience (SCR).
- The direct impact of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP).
- The direct impact of Supply Chain Resilience (SCR) on Supply Chain Performance (SCP).
- The indirect impact of Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP) through the mediation of Supply Chain Resilience (SCR).
- The values above the path lines (straight lines) show the path coefficients of the independent variables under study, while the values (e_i) represent the path coefficients corresponding to the error, which reflect the size of an unexplained variance due to an error not determined by the independent variables.

The following are the results of the path analysis model for the relationships between variables, as in the following table:

Paths	Standardized β			S.E.	C.R.	<i>P</i> -Value	The Coefficient of Determination R2
	Impact coefficient values						
Y <-- X	(Digital Supply Chain Technology (DSCT)) on (Supply Chain Performance).	-0.158	0.050	-3.129	0.002	0.402	
Y <-- Z	(Supply chain Resilience (SCR)) on (Supply Chain Performance).	0.784	0.053	14.706	000		
Z <-- X	(Digital Supply Chain Technology (DSCT)) on (Supply chain Resilience (SCR)).	0.574	0.038	15.288	000	0.368	

We note from the previous table that:

- The value of the Critical Ratio for Regression Weight (CR) calculated for Digital Supply Chain Technology (DSCT) on Supply Chain Performance (SCP) is less than the tabular value (± 1.96); in addition to that, the level of significance for this axis is less than (0.01), and this indicates that this axis is significant.
- The value of the Critical Ratio for Regression Weight (CR) calculated to Supply chain Resilience (SCR) on Supply Chain Performance (SCP) is greater than the tabular value (± 1.96); in addition to the level of significance for this axis is less than (0.01), and this indicates that this axis is significant and has an impact Statistically significant on Supply Chain Performance (SCP).
- The value of the Critical Ratio for Regression Weight (CR) calculated for Digital Supply Chain Technology (DSCT) on Supply chain Resilience (SCR) is greater than the tabular value (± 1.96); in addition to that the significance level of this axis is less than (0.01), and this indicates that this axis is significant and has a statistically significant effect on Supply chain Resilience (SCR).
- It is noted that the value of the determination coefficient (R^2) for the dependent variable Supply Chain Performance (SCP) amounted to (0.402), meaning that the independent variable Digital Supply Chain Technology (DSCT) and the mediator variable Supply Chain Resilience (SCR) explain (40.2%) of the total change in the dependent variable Supply Chain Performance (SCP), and the rest of the percentage is due to random error, or it may be due to not including other variables that were supposed to be included in the model.
- It is noted that the value of the determination coefficient (R^2) for the mediator variable Supply Chain Resilience (SCR) amounted to (0.368), meaning that the independent variable Digital Supply Chain Technology (DSCT) explains (36.8%) of the total change in the d mediator variable Supply Chain Resilience (SCR) and the rest of the ratio It is due to a random error, or it may be due to not including other variables that should have been included in the model.
- The value of the Standard Error (SE) for all paths is less than 40%, which indicates a low variance for this model.
- The mediator variable is considered a partial intermediate variable in the relationship, and not a full intermediate variable in the relationship.
- According to the previous results, we accept the Hypothesis, "Supply Chain

Resilience (SCR) has a mediating role in the relationship between Digital Supply Chain Technology (DSCT) and Supply Chain Performance (SCP)”.

- This was consistent with the previous studies of [Bahrami et al. \(2022\)](#). Their findings demonstrated that BDA (Big Data Analytics) capabilities had a significant positive effect on SC resilience, SC innovation, and SC performance, with SC resilience and SC innovation identified as the significant mediators. The main findings of this study are that BDA capability can be a strategic investment in improving SC performance, and also companies should invest in SC resilience and SC innovation development supported by BDA capabilities, since they are effective mediators between BDA capabilities and SC performance. Also, the study of [Belhadi et al. \(2021\)](#) demonstrated that AI (Artificial Intelligence) information processing capabilities significantly influence SCP directly by enhancing related metrics or creating a long-lasting SCP through SCR building. Notably, the development of a sustained SCP requires firms to develop AI capabilities to enhance SCR through its main enablers, AC (Adaptive Capabilities) and SCC (Supply Chain Collaboration), under the dynamism and uncertainty of the supply chain environment.

5. Conclusion

5.1. The Results

- The results obtained from this study extend the knowledge on how the potential benefits of digital supply chain technology (DSCT) can be reaped by the industrial companies in Egypt, and this study has filled the knowledge gap by demonstrating how DSCT has a positive effect on supply chain performance and how supply chain resilience can serve as a mediating role between DSCT and the SCP. Resilience will allow Egyptian industrial companies to handle disruptions effectively.
- Difficulties facing global supply chains are not far from supply chains in Egypt, and they are experiencing the shattering effects of supply chain failures such as natural catastrophes, product counterfeits, political instability, including dissenting activities from different groups, corruption, transportation infrastructure, and other unethical business practices tend to be acute in this part of the world ([Stevenson & Busby, 2015](#)). That means Egyptian industrial companies should be concerned about developing their resiliency capabilities, due to the globally connected world as well as the repercussions and significant effects of disturbance events. Supply chain resilience capabilities can be promoted through strong integration between the company's supply chain and the supply chain partners. Collaborations and strategic partnering may permit accurate information flow and knowledge exchange across the whole supply chain network, and this can be supported by using digital supply technologies. In turn, this would help in facilitating the companies to oversee the entire supply chain process. In this way, these companies would also be able to sense any disruptions and respond to them promptly. This is important as failure to re-

spond promptly to unforeseen circumstances may lead to deterioration in supply chain performance, thereby affecting firm competitiveness.

5.2. Further Studies

- The results of the statistical analysis showed that, the percentage of effect of the independent variable Digital Supply Chain Technology (DSCT) on the dependent variable Supply Chain Performance (SCP) is 79%, and the rest of the percentage is due to random error or may be due to other independent variables not included Model, so the next researches can try to investigate for the other independent variables not included Model which could affect the Supply Chain Performance (SCP).
- The results of the statistical analysis showed that, the percentage of effect of the independent variable Digital Supply Chain Technology (DSCT) on the mediator variable Supply chain Resilience (SCR) is 40.2% and the rest of the percentage is due to random error or may be due to other independent variables not included Model, so the next researches can try to investigate for the other independent variables not included Model which could affect the Supply Chain Resilience (SCR).
- The results of the statistical analysis showed that, the percentage of effect of the mediator variable Supply chain Resilience (SCR) on the dependent variable Supply Chain Performance (SCP) is 38% and the rest of the percentage is due to random error or may be due to other independent variables not included Model, so the next researches can try to investigate if any other mediator variables not included Model which could affect the Supply Chain Performance (SCP).
- The results of the statistical analysis showed that, the independent variable Digital Supply Chain Technology (DSCT) and the mediator variable Supply chain Resilience (SCR) can explain (40.2%) of the total change in the dependent variable Supply Chain Performance (SCP), and the rest of the percentage is due to random error, or it may be due to random error or other variables that were supposed to be included in the model, so the next researches can try to investigate if any other independent variables or mediator variables not included in the model which could affect the Supply Chain Performance (SCP).
- The results of the statistical analysis showed that, Independent variable Digital Supply Chain Technology (DSCT) explains (36.8%) of the total change in mediator variable Supply Chain Resilience (SCR), and the rest of the ratio It is due to a random error, or it may be due to variables that should have been included in the model, so the next researches can try to investigate if any other independent variables not included in the model which could affect the Supply Chain Resilience (SCR).
- This study was applied to the Egyptian Industry sector, and further studies could be applied to other sectors like service companies.

5.3. Recommendations

Digital supply chain technology and supply chain resilience become vital components for achieving a high performance of the supply chain. So it has become very important that industrial companies invest in obtaining and applying digital supply chain technology and adopting and applying supply chain resilience principles. By using the tools of digital supply chain technology to enhance supply chain resilience, industrial companies can support and enhance their supply chain performance; organizations can increase efficiency, reduce risks, and create a more sustainable future.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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