administrative sciences

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Supply Chain Resilience and Operational Performance: The Role of Digital Technologies in Jordanian Manufacturing Firms

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Abstract: This study aims to analyze the relationship between supply chain resilience (SCR) practices and operational performance and the moderating role of digital technologies in Jordanian manufacturing firms. A descriptive-analytical approach was adopted using a questionnaire based on the study model and previous related literature. Four hundred supply chain (SC)-related managers within seventy-one firms were reached to collect the needed data; three hundred and seventy-two complete questionnaires were analyzed. The results revealed that the level of SCR practices and operational performance was high; SCR (with its sub-dimensions: SC agility (SCA), SC flexibility (SCF), and SC collaboration (SCC)) had a significant positive relationship with operational performance; and the appropriate use of digital technologies had a significant moderating impact on the aggregate level of the SCR–operational performance relationship. Finally, research limitations, practical implications, and future research conclude this study.

Keywords: supply chain resilience; supply chain agility; supply chain flexibility; supply chain collaboration; operational performance; manufacturing firms; digital technologies

Citation: Alkhatib, Saleh Fahed, and Rahma Asem Momani. 2023. Supply Chain Resilience and Operational Performance: The Role of Digital Technologies in Jordanian Manufacturing Firms. *Administrative Sciences* 13: 40. https://doi.org/10.3390/admsci13020040

Received: 31 December 2022
Revised: 23 January 2023
Accepted: 26 January 2023
Published: 30 January 2023

1. Introduction

Most recently, the efficiency of supply chain management (SCM) and supply chain resilience (SCR) have been topics that are widely discussed in both academic and manufacturing environments (Alkhatib 2022; Pournader et al. 2016). Much of this attention is due to globalization and global pandemics requiring firms to integrate their overall supply chain (SC), seeking to enhance resource use, develop abilities, and ensure firm continuity. SCM involves all actions related to the flow of goods, information, money, and the efficient management of these resources through various firms. Although the purpose of SCM is to obtain the effectiveness of the product flow and increase SC profitability, each operation in an SC, however, has associated risks due to the presence of uncertain and vague information that can be disrupted (Pournader et al. 2016). Therefore, SCR as the ability to mitigate most SC disruptions and limit the impact of those that occur is a crucial issue to consider.

Every firm faces several risks that can lead to the disruption of information and materials. SCs are extremely vulnerable to internal and external disruptions such as economic downturn flows, difficulties resulting from the loss of valued buyers, and new technology and infrastructure quality. Operational performance can be threatened in several areas of the SC. Most firms operate in a highly competitive business environment, exposing the SC to a variety of challenges that have negative impact on markets, industries, and how they will grow in the future. Some of these disruptions may be easy to manage, but others may not be and may have a greater impact on the firms' and SCs' performance (Wamba et al. 2020; Abeysekara et al. 2019). Additionally, the negative consequences of the COVID-19 crisis, especially to manufacturing SCs, such as cross-border or temporary shutdowns of manufacturing sites and restricted transportation, resulted in supply shortages, which hindered continuing manufacturing processes. The intensity of the COVID-19 outbreak made SCM uncontrolled and unpredictable. According to the World Economic Forum (2020), COVID-19 caused billions of dollars in losses around the world, with the overall economic impact and duration of those losses difficult to assess. Furthermore, businesses lack knowledge on how to deal with the COVID-19 crisis and make their SCs resilient (Belhadi et al. 2021). Hence the concept SCR refers to the SCs' ability to benefit the carrying capacity of SC entities to block and resist the impacts of instability; by utilizing adaptive capacity, it is possible to reduce the consequences of disruptions and their spread to restore performance levels to normal operations in a cost-effective way by using utilizing restorative capacity if absorptive and adaptable capacities are insufficient (Hosseini et al. 2019). In order to overcome these current challenges, manufacturing companies must maintain and develop new methods of reinforcing both proactive and reactive supply resilience capabilities that guarantee the long-term success of operational performance (Belhadi et al. 2021). Firms with a resilient SC can deal with large economic crises in a more manageable manner (Pettit et al. 2019).

Additionally, most firms have realized the importance of SCR in their businesses under the influence of the application of digital technologies. Due to the technological development that the world is witnessing, the use of digital technologies has provided support in several areas such as decision-making processes regarding the formation of SC operations; analyzing and providing accurate data in a timely manner; and creating better interfaces among SC partners, and therefore, this leads to better SC integration and helps to discover potential disruptions before they spread (Ivanov and Dolgui 2020). Firms can respond immediately to changes in a timely manner, and therefore, when disruption occurs, the presence of digital technologies helps mitigate the negative impact on operational performance and improves the performance of the SC. Therefore, several studies (Alkhatib 2022; Belhadi et al. 2021; Eslami and Scholz 2021; Ivanov and Dolgui 2020; Abeysekara et al. 2019; Chowdhury et al. 2019; Altay et al. 2018) suggest investigating the relationships between SCR and operational performance and/or testing the role of adopting digital technologies over this relationship.

Developing countries play an important role in the global SC and encounter SC disruptions, whereby many companies in developing countries are exposed to numerous risks and disruptions because of the political., economic, and cultural conditions within these countries (Tukamuhabwa et al. 2017). In the Jordanian context, the manufacturing sector—which directly contributes to about 25% of GDP—plays a crucial role in strengthening the pillars of economic and social growth, due to its significant role in employment, attracting qualitative investments, accessing global markets, and improving the image and identity of Jordanian products (Jordan Industry Chamber). Despite the importance of studying issues of disruption and SCR, it has not received the attention of researchers in developing countries (Alkhatib 2022). The literature focuses on the impact of SCR on operational performance under the influence of applying digital technologies to developed countries, with little attention to developing ones. This study aims to help in filling this gap by studying the resilience of the SC and its impact on operational performance under the influence of applying digital technologies within the Jordanian manufacturing sector. Bearing this in mind, one can ask the following question: is there a significant relationship between manufacturing SCR and operational performance under the appropriate use of digital technologies in the Jordanian manufacturing sector?

The rest of the paper is structured as follows: Section 2 presents the general background. Section 3 reviews the relevant literature, summarizes the main findings, and identifies the main research gaps. Section 4 demonstrates the study methodology. Section 5 presents the study results and Section 6 discusses them. Finally, Section 7 concludes this study, suggests some of the theoretical and practical implications, and sets the agenda for suggested relevant research.

2. Supply Chain Resilience and Operational Performance: General Background

A typical SC involves various participants who perform a sequence of activities in moving physical goods or services from a point of origin to a point of consumption (Crandall et al. 2015). Meanwhile, SCM is defined as the planning and management of all of the activities involved in sourcing and procurement, conversion, and all of the logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies (CSCMP 2016). Demand management is another term for SCM, the system that includes information, people, technology, resources, and actions that transport goods or services from a supplier to a customer. The role of the SC is to add value when moving products/services from one location to another (Janvier-James 2012), therefore maximizing the net value generated and growing the overall SC surplus (Chopra 2019). It also contributes to the improvement of performance, and accordingly, the success or failure of all the SC members. Because a company's relationship with the environment is essential to its survival and existence, responding to and adjusting to changes in the environment is critical for business leaders to establish SC strategies that are responsive to these changes. Recent literature studies on SCM have focused on existing challenges and major disruptions such as big data analytics, the Internet of Things, blockchain, and the extension of Industry 4.0 (Aryal et al. 2018; Bălan 2020; Queiroz et al. 2019). Therefore, SCs are vulnerable to a variety of unexpected events given today's global and increasingly volatile market environments, which disrupt their operational activities and decrease performance, resulting in reduced revenues, supply delays, loss of market shares and reputation, a decline in stock return, and so on. (Yildiz et al. 2016; Ivanov et al. 2019). Furthermore, international trade leads to global SCs, and SCM is fraught with risks; globalization and trade freedom have expanded SCM's vulnerability and risks (Gurtu and Johny 2021). Risk management can be thought of as the process of identifying and controlling risk to an acceptable level using strategies, methodologies, and supporting resources. According to Dong and Cooper (2016), traditional SC risk management (SCRM) literature is divided into two categories: ex ante SCRM and ex post SCRM. The first form of risk management focuses on proactive planning by first identifying and assessing risks, then improving SCM by implementing techniques such as SC integration, multilevel procurement strategies, inventory management, etc. The second form of risk management focuses on reactive planning after a specific risk has occurred; ex post SCM attempts to design and adopt a risk reduction strategy in response to risks. Given the unexpected turbulence in the business environment, building a resilient SC has become necessary to address unexpected risks and disruptions (Aslam et al. 2020). Resilience is a multidimensional concept that has been defined by numerous scholars, for example: Christopher and Peck (2004) defined it as the ability of a system to recover and return to its previous condition. In an organizational context, resilience can be characterized as the organizational capability that allows the organization to survive in a dynamic environment (Ates and Bititci 2011). Tukamuhabwa et al. (2015) defined SCR as an SC's adaptive ability to forecast and/or respond to disruptions to recover in a timely and cost-effective manner, and, as a result, advance to a post-disruption operational state—ideally, a better condition than before the disruption. Brandon-Jones et al. (2014) described SCR as the ability of SCs to back into current operating performance after being disturbed for a reasonable amount of time. Hohenstein et al. (2014) described SCR by evaluating sixty-seven papers from 2003 to 2013 as the capacity to respond to, deal with, adjust to, or suffer unpredictable situations (i.e., risk) and proposed four stages: recovery, readiness, response, and growth.

Resilient SCs are required to do more than simply resist and recover; they need to be built using processes and modern SC technologies to forecast, anticipate, and quickly respond to both SC risks and opportunities. The importance of SCR is given by the various internal and external disturbances caused by humans or the environment that SCs face and which lead to their weakness given the increasing complexity arising from global interactions (Tukamuhabwa et al. 2015). Environmental disasters, technical transformations, critical supplier terrorism, political turbulences, and other disruptions are examples of potential disruptions (Pavlov et al. 2018) that could cause monetary and operational damages or the SC's complete shutdown (Tukamuhabwa et al. 2015). These consequences of SC disruption have other applications which are described as "*ripple effects*" (Kinra et al. 2020).

Resilience is the initiative-taking ability to limit the actual impact of risk, especially in an uncertain SC environment (Hasani and Khosrojerdi 2016). SCR can be used as the capability to adapt, survive, and grow in dealing with turbulent changes in product and service sourcing, manufacturing, and delivery. Therefore, resilience is a required equivalency in an environment with significant levels of SC risk and uncertainty to reduce SC vulnerability, minimize the ripple impact (Dubey et al. 2021), and therefore improve SC performance.

3. Literature Review

Several previous studies have indicated that SCR practices are being studied extensively. Sand (2021) mentioned three solutions for SCs to increase their resilience: first, the use of tracking technology which is considered as one of the artificial intelligence techniques that is commensurate with the risks and pressures that the SC is exposed to, and which helps in learning from past experiences. Second, building trust and shared value among all of the SC members. Third, identify SC weaknesses because vulnerabilities might occur at any point along the SC. Tukamuhabwa et al. (2017) developed and added four key strategies of SCR that were covered in the literature. These strategies can improve the SCR through flexibility, creating redundancy, SCC, and SCA. According to Zhuo et al. (2020), three dimensions of SCR work to improve the dynamic process of how the SC process system prepares, responds to, and recovers from risks through preparedness, response and adaptation, and recovery. Other firms may engage in SC integration (SCI) activities for financial reasons and reduce SC risks and avoid disruptions (Jajja et al. 2018). Other studies have indicated two potential strategies that make SCs more resilient (Belhadi et al. 2021; Tukamuhabwa et al. 2017): initiative-taking and reactive strategies. To achieve these strategies, capabilities must be developed that have a long-term positive impact on SCR (Belhadi et al. 2021). The capabilities of initiative-taking strategies include integrated SCRM, localization/regionalization of sourcing, digital connectivity, SC automation, SCC, and a social SC focus, whereas the capabilities of reactive strategies include agility, flexibility, rapidity, and reconstruction (Altay et al. 2018). Additionally, the costs of developing a SCR strategy and putting it in place should be considered when deciding on a strategy (Tukamuhabwa et al. 2015). This study focuses on SCA and SCF as representative of reactive capabilities and SCC as representative of initiative-taking SCR capabilities and their impact on operational performance.

SCR as the capacity to decrease the likelihood of dealing with unexpected disruptions, resist disruptions from spreading by maintaining control over structures and functions, recover from disruptions, and respond by implementing rapidly and effectively reactive plans to deal with the disruption and return the SC to a stable state of operations (Kamalahmadi and Parast 2016) is expected to have a direct positive impact on firms' operational performance. Alkalha et al. (2021) pointed to SCR as the mediating factor linking absorptive capacity and operational performance to international organizations. The results showed that SCR has a partial mediating effect between absorptive capacity and operational performance and SCR has a strong impact on operational performance. Chowdhury et al. (2019) explored the operating context in which SCR enhances enterprise SC performance for Bangladeshi manufacturing firms. A moderate link between SCR and performance has been revealed. Hence, it is reasonable to assume that SCR has a positive impact on operational performance. This study assumes that SCR positively affects operational performance and therefore, the following hypothesis was developed:

H1: *SCR has a significant positive impact on the operational performance of Jordanian manufacturing firms*

3.1. Supply Chain Agility (SCA)

As emphasized by Smith et al. (2021), SCA has potential impacts on various performance areas, including market, financial, and operational performance. The creation of an agile SC may involve participation from manufacturing companies ranging from raw material suppliers to manufacturers and distributors. Despite the benefits of SCA, there are still challenges in establishing an agile SC (Gunasekaran et al. 2019). SCA requires strong collaboration with SC partners in terms of information sharing (Fayezi and Zomorrodi 2015), rapid changes in delivery time, design, product enhancements, product introduction, and production capability to fulfill consumer demand as cost-effectively as feasible (Al-Shboul 2017) and real-time decision-making, tracking and tracing, and risk sharing. The agility of a firm's SC refers to its capacity to respond rapidly to consumer needs while also maintaining costs in check (Golgeci et al. 2019); these requirements can only be achieved using advanced digital technology. Panigrahi et al. (2022) examined the relationship between SCA and operational performance in India. A strong relationship between agility in the SC and operational performance development has been improved. It is also possible to improve the SCA by integrating information systems which increases the role of digital technologies. The information systems and digital technologies enabled by agility in the SC provide significant operational benefits, including improved working efficiency, improved information visibility, lower inventory levels, faster response times, and more accurate forecasts. This study assumes that SCA positively affects operational performance and therefore, the following hypothesis was developed:

H1.1: *SCA has a significant positive impact on the operational performance of Jordanian manufacturing firms.*

3.2. Supply Chain Flexibility (SCF)

Relevant research considers SCF as the ability of a system—such as a manufacturing firm—to respond to undesired system changes such as equipment breakdowns, inventory control, varying task times, and reworking (Huo et al. 2018). It is the firm's ability to alter or respond to uncertainty. Several studies have examined flexibility and SCF in the context of manufacturing firms. For example, Yu et al. (2018) stated SCF as a firm's capacity to acquire, process, and transfer information to enable efficient and successful SC activities. Therefore, SCF can be described as a firm's capacity to adjust SC processes in response to environmental changes to improve performance (Shukor et al. 2020). Many firms have used SCF to build capabilities and adapt changes to match market requirements so that they may achieve a competitive advantage and superior business performance (Centobelli et al. 2020). According to Eltawy and Gallear (2017), the goal of SCF is to improve mass production in addition to producing products correctly the first time, in the right way without errors. SCF can reduce costs, increase inventory turnover, reduce lead times, and reduce defects, as these advantages encourage firms to improve their SC (Shahin et al. 2016).

SCF is classified in a variety of ways in the literature; for example, flexibility in SC activities from upstream to downstream (Singh et al. 2019), volume flexibility, and process flexibility. Upstream flexibility is manufacturing and operational flexibility that involves a process, scale, diversity, and the participation of workers and suppliers (Luo and Yu 2016). Volume flexibility refers to a company's ability to modify capacity based on consumer demand (Fayezi and Zomorrodi 2015). Downstream flexibility is logistics activities that oversee completed goods inventory distribution, warehouse management, and transportation to satisfy customers' needs (Rojo et al. 2018). The degree to which firms can collaborate with key SC partners affects their SCF. For example, suppliers can be involved in the product development process by providing extra capabilities and quality resources. Meanwhile, customers in other streams can provide valuable feedback on product features, pricing, quality issues, and other inputs. Therefore, SCF allows a company to adapt to change in an uncertain environment; it is a form of SCR that gives the ability to respond rapidly to dynamic environments and return to a normal situation in the face of existing disruption (Rajesh 2020).

Yu et al. (2018) discussed proactive and reactive flexibilities, which are the flexibility of the firm's SC in the ability to access data and convert them into accurate information to make the right decisions that can improve operational performance. In this context, Khanuja and Jain (2021) pointed to SCF as a mediating factor between SCI and SC performance in India. Therefore, flexible organizations are typically more proactive in managing uncertain environments. Hence, this study assumes that SCF positively affects operational performance and therefore, the following hypothesis was developed:

H1.2: *SCF has a significant positive impact on the operational performance of Jordanian manufacturing firms.*

3.3. Supply Chain Collaboration (SCC)

Due to the highly competitive global market, collaborations in the SC network have become a crucial need for all SC members. Collaboration is defined as the ability to respond to SC disruptions with partners by collaborative planning, knowledge, and information sharing to organize an immediate response (Scholten and Schilder 2015). SCC is defined as two or more separate firms collaborating to plan and implement SC operations (Jimenez-Jimenez et al. 2018). According to Routroy et al. (2018), collaborations in SCs are crucial, and this cannot be emphasized enough. SCC has numerous advantages in terms of not only efficiency and effectiveness, but also resource usage and productivity, as well as SC visibility, stakeholder satisfaction, and trust (Yang et al. 2018). Firms benefit from collaborative connections for a variety of reasons, the most important of which are risk and information sharing and access to complementary resources, both of which contribute to improving financial performance and competitive advantages. Even though the concept of collaborative SCs has been studied in an acceptable manner, many SC partners have failed to perform their role in ensuring mutual advantages (Baah et al. 2021). According to Feizabadi et al. (2019), SCC is considered as the driving force behind successful and effective SCM techniques. The authors indicated that SCC practices are essential in establishing consistent capabilities and thus improving performance. Cooperation processes help in building strong relationships with SC partners due to collaborative efforts based on accurate and timely information from all partners (Wamba et al. 2020).

To achieve the goals of SCC, relevant and meaningful data must be shared across the SC. Panahifar et al. (2018) suggested that relevant and helpful information should be accurate, dependable, timely, beneficial, and easily accessible which works on enhancing SC operational performance, which increases the importance of digital technologies in SCM.

Salam (2017) found that SCC plays a key role in achieving superior operational performance. Salam (2017) explained how trust and technology work together to create SCC that improves operational performance. Scholten and Schilder (2015) showed that SCC activities have an impact on increasing SCR. For instance, by encouraging close interaction with SC partners, consistent goals and actions for the initiative-taking prevention and assessment of potential risks can be established (Belhadi et al. 2021). From another point of view, Shahbaz et al. (2018) found that SCC significantly affects operational performance in terms of information sharing and joint decision-making, while electronic data interchange (EDI) does not have a significant effect. Mohammed Nassir alkasb et al. (2021) examined the relationship between SCC and operational performance through the moderate role of SC complexity in Oman. The results revealed that information-sharing, goal congruence, and knowledge-sharing of SCC dimensions have a positive impact on operational performance. Therefore, this study assumes that SCC positively affects operational performance and therefore, the following hypothesis was developed:

H1.3: *SCC has a significant positive impact on the operational performance of Jordanian manufacturing firms.*

3.4. Operational Performance

Primarily, operational performance is measured in terms of flexibility, cost, quality, and delivery (Khan et al. 2022; Santoso et al. 2022; Thoumy and Jobin 2020; Usman et al. 2020; Nabass and Abdallah 2019). A company's operational performance also highlights its competitive position among firms in the SC, and to enhance performance, each firm in the SC must improve its overall operating efficiency (Santoso et al. 2022). As Usman et al. (2020) explained, operational performance is what can be achieved by a person or group of people in an organization to achieve organizational goals in accordance with the authority and responsibility concerned. The concept of operational performance is concerned with measuring the degree to which an organization is successful in maximizing its use of available resources, focusing on several key aspects, such as quality, cost, flexibility, and time (delivery) (Hallgren and Olhager 2009). Operational performance refers to organizations' ability to manage operational objectives or services for operational characteristics such as on-time delivery, reduced lead times and cycle times, and other key contributors to improve resource utilization and cost reduction. Therefore, it is considered a competitive advantage if a company scores higher in one of the operational performance indicators due to a tactical resource, which is nearly used as a substitute for operational performance (Chahal et al. 2020). Santoso et al. (2022) used five indicators to measure operational performance: (1) improvement of the quality of the product, (2) reducing lead times or speeding up the delivery process, (3) increasing its competitive position in the market, (4) enhancing product development, and (5) an increase in international sales.

Because the operational function is so essential in developing and maintaining competitiveness, manufacturing firms must develop operational plans to assist in the implementation of their corporate competitive strategies. These plans need to be consistent among the SC members and require the highest level of cooperation within a resilient SC. Manufacturing competitive priorities are the tactics that a company may take to decide how to compete in the marketplace and which markets to target (Khan et al. 2022), which requires a high level of SCR and advanced digital technologies.

3.5. Supply Chain and Digital Technologies

The concept of digital technologies has been promoted by the simultaneous use of several internet-connected technologies (Ghobakhloo 2020). Digitalization is described as the use of computer and Internet technology to create economic value more efficiently and effectively (Reddy and Reinartz 2017). Cyber-physical systems (CPS), artificial intelligence, the Internet of Things (IoT), big data analytics (BDA), and cloud computing are examples of digital technologies that promote connectivity, integration, and automation within business operations (Ivanov et al. 2019). As mentioned by Kavanagh et al. (2015), a variety of tools from many fields of technological growth are being investigated. Data communication from and to various sensors, computers, and machines is made easier by IoT technologies. Cloud computing enables more efficient data storage, sharing, and analytics. In addition, data mining and artificial intelligence enable data to be processed in a more intelligent and efficient manner (Verboven et al. 2020). Actually, the mentioned digital technologies are the enabling technologies for Industry 4.0 (Li et al. 2020). Industry 4.0 refers to intelligent factories in which digital technologies are synergistically combined inside a production system's fundamental architecture (Zheng et al. 2021). To meet the new age of fluctuations and complexity, SCs must be integrated with evolving consumer desires to manage increasing dynamics in the business environment (Christopher and Holweg 2017). In SCM, improved data processing capabilities have created new capabilities that have helped in improving SC operations. Value chain analysis is promoted by digital SC to consider and pre-empt unpredictable business disruption so that organizations can gain a competitive advantage (Linkov et al. 2020).

According to Ivanov et al. (2019), the digitalization of track technologies and trace SC applications is allowed by an enhancement in the data quality of SC technologies. As a result, data quality may be able to assist businesses in relying on SC technology expertise while making effective decisions in the case of a disaster. Even though digital technologies have a variety of positive consequences, the potential of digital technologies is not yet fully exploited, especially in developing countries (Buer et al. 2021). Schlechtendahl et al. (2015) claimed that only a small percentage of existing manufacturing systems are highly interconnected. This is mostly due to difficulties with the complex application in a manufacturing environment (Warner and Wäger 2019). Most of the SC partners, particularly in the context of manufacturing SCM, vary in their level of digital maturity and, consequently, in their data management capabilities (Wu et al. 2013). As found in a study by Tyagi et al. (2014), many firms' computational infrastructure is insufficient for the efficient processing of data created by digital technologies.

However, the expected optimization of digital technologies as a digital SC strategy increases digital threats. Several digital threats need to be considered while implementing these new technologies. For example, cyberattacks, data privacy, security issues, and information leaks in blockchains are crucial digital threats to consider. According to Yang et al. (2021), although the adoption of digital technology affects SC efficiency, structure, and innovation, adoption drivers and expected threats influence the adoption process and the expected impact of this adoption. Therefore, inappropriate adoption of digital technologies may increase SC risk, uncertainty, and/or cyber threats.

To be more resilient in times of disruption, sharing information, digital technologies including cloud applications, and big data analytics are required to efficiently transfer relevant data among SC members. Through the shared information, SC digital technologies can find a solution to reducing lead times which results in enhanced operational performance (Raji et al. 2020). Furthermore, these data analytics tools can be used as digital learning systems to enhance initiative-taking and reactive measures in the case of a disruption, thereby improving SCR and operational performance (Ivanov et al. 2019). Because of improved accuracy and transparency, digital technology can offer the SC network data-driven decision help and support for measures and potential solutions to defend against potential disruptions (Ivanov and Dolgui 2020). Additionally, digital technologies such as big data or tracking and tracing technologies further improve the capacity of supply networks to be ready for disruptions based on the integrated SCs that are designed to proactively render supply systems more resilient. For instance, by coordinating SC partners' capacity plans which are matched to the demand (Ivanov et al. 2019).

Therefore, using appropriate digital technologies could enhance the benefits of an agile reaction, which involves quickly modifying the SC to a disruption, on improving SCR (Ivanov et al. 2019). Consequently, the application of digital technologies is expected to enhance the positive relationship between SCR and operational performance. This study assumes that digital technologies moderate the SCR-operational performance relationship, and therefore, the following hypothesis was developed:

H2: *Digital technologies moderate the relationship between SCR and operational performance.*

Based on the previous literature, this study conceptualized the relationship of SCR on the operational performance of Jordanian manufacturing firms with the existence of SC digital technologies (Figure 1).

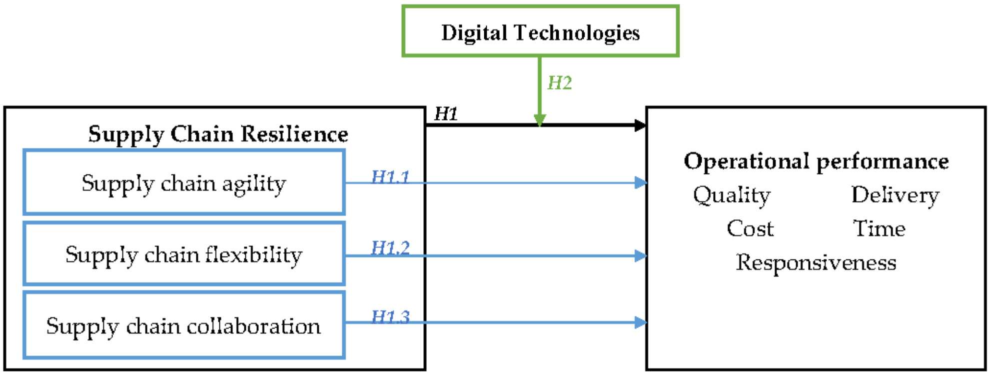

Figure 1. Research model.

4. Methodology

Given the nature of this study and the objectives to be achieved, a descriptive-analytical approach was adopted. Various relevant studies have been reviewed to build the research model and hypotheses. Then, data needed to be collected and analyzed to test these hypotheses. Therefore, the study population, sampling design, and data collection tools are crucial issues to consider. Additionally, the analyzing and testing tools and the validity, reliability, and readiness of the data need to be considered in a way that facilitates understanding the study results and comparing them with relevant studies and presenting the study's recommendations to reach conclusions that contribute to the development and improvement of reality.

4.1. Study Population and Sampling

In the Jordanian context, the manufacturing sector—which directly contributes to about 25% of GDP—plays a crucial role in strengthening the pillars of economic and social growth, due to its significant role in employment, attracting qualitative investments, accessing global markets, and improving the image and identity of Jordanian products. This contribution rises up to 40% of GDP due to its close engagements with various other sectors. It employs more than 250,000 Jordanian workers, who work in more than 18,000 manufacturing establishments, making up about 21% of the total Jordanian workforce (Jordan Industry Chamber). Despite the huge number of Jordanian manufacturing establishments, most of them are considered as small to medium-sized ones (based on the number of workers <50 and/or working capital). The population of this study consists of all of the industrial firms operating in Jordan. The process of identifying manufacturing firms was represented by a visit to the Jordanian Ministry of Industry and Trade. Seventy-nine industrial listed firms were reached. For each firm, 3 to 10 questionnaires were planned to be distributed based on the size of the firm (number of workers) and the number of managerial positions that are related to/aware of SC concepts. Therefore, the expected sample size was estimated to be 237 up to 790. Seventy-one manufacturing firms agreed to participate in this study. Based on availability and the level of cooperation, only four hundred questionnaires were distributed by hand to the following managers: SC, inventory, procurement, production/operations, customer relationship, and marketing. A total of 372 questionnaires out of the 400 distributed ones were returned and were valid to be analyzed. For this sample, the study questionnaire contained four demographic factors, Table 1.

Table 1. Demographic profile of respondents (N = 372).

Variable	Category	Frequency	Percentage (%)
Age	Less than 25 years	55	14.8%
	From 25 years old to 35 years old	136	36.6%
	From 36 years old to 45 years old	98	26.3%
	Over 45 years old	83	22.3%
Gender	Male	241	64.8%
	Female	131	35.2%
Academic qualifications	High school diploma or less	99	26.6%
	Intermediate diploma	105	28.2%
	Bachelor	123	33.1%
	Postgraduate	45	12.1%
Years of experience	Less than 5 years	115	30.9%
	From 5 to 10 years	123	33.1%
	From 11 to 15 years	72	19.4%
	More than 15 years	62	16.7%
	Total	*372*	*100%*

4.2. Data Collection Tool

Data were collected through a questionnaire developed for this study. The respondents were selected based on their specialization and relevant experience. First, the researchers visited each firm and discussed the research idea with the management to assure the needed approvals for the distribution. Moreover, the researchers explained the importance of the study and confirmed the confidentiality of the data before distributing the questionnaire. Face-to-face data were collected. The researchers then distributed the questionnaires to the managers that agreed to participate in the study.

In addition to the demographic section (Table 1), the questionnaire consists of five main sections. Section 2 uses 5 items to measure SCA, Section 3 uses five items to measure SCF, Section 4 uses 5 items to measure SCC, Section 5 uses 10 items to measure operational performance, and finally, Section 6 uses 5 items to measure digital technologies. Section 4.4 provides more details about the study variables, their supporting references, measures, and scales with their descriptive statistics.

4.3. Data Analysis

For the collected (372) questionnaires, a data analysis stage was performed using the social package for social sciences [SPSS] v.26. More specifically, the following tests and analysis tools were performed: Cronbach alpha to support the statistical reliability of the scales; Pearson correlations to support the internal consistency of the scales; variance inflation factor (VIF), tolerance, and Pearson correlation to examine multicollinearity between the SCR constructs; descriptive statistics, frequencies, and percentages to gather counts and frequencies for respondents' demographics, mean, and Std. to interpret overall sample agreement levels; the Kolmogory–Smirnov test and kurtosis and skewness to check for data normality; simple linear regression models to assess for the impact of SCR on OP; one-way analysis of variance (ANOVA) to compare the mean values for three groups or more; and post-test LSD Fisher to identify the source of difference in case of significant ANOVA.

4.4. Variables and Measures

First, for the dependent variable (SCR), three dimensions were adopted: SCA, SCF, and SCC. These dimensions were selected based on previous studies in the literature.

Below is a description of each dimension and its measure and their descriptive statistics. Items for all measures were captured using a 5-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree). To be able to describe and analyze the practices according to the variables, the arithmetic averages and standard deviations were calculated and used to determine the relative importance of each study paragraph and their variables, by applying the category length equation that measures the level of practice of the study variables (Sekaran and Bougie 2016). Therefore, a three-level scale suggests a high-level range (3.68–5), moderate-level range (2.34–3.67), and low-level range (1–2.33).

SCA: This study is based on the Eckstein et al. (2015) definition of SCA and uses the Al-Shboul (2017) scale to measure it. Five items have been used to operationalize this dimension. The used measure items and their statistics are in Table 2.

Table 2. SCA Measurement (N = 372).

Rank	Number of Contents	SCA (Al-Shboul 2017)	Mean	S. D	Level
1	3	Our supply chain responds quickly when introducing/entering new products to the market.	4.0188	0.84494	High
2	1	Our supply chain responds quickly to changing delivery time requirements.	4.0081	0.91554	High
3	2	Our supply chain responds quickly to changing product design requirements.	4.0081	0.83549	High
4	4	Our supply chain maintains high responsiveness to market volatility.	3.9677	0.85563	High
5	5	Our supply chain responds quickly if improvements are made to the structure or performance of the chain.	3.6022	0.97836	Moderate
		Total mean value	3.921		high

SCF: According to Rajesh (2020), SCF is described as a company's ability to alter SC processes to increase performance in response to environmental changes; in addition, it allows a company to adapt to changes in an unpredictable environment and improve SCR to deal with fluctuating demand in market fluctuations. Five items adopted from the Chandak et al. (2021) scale have been used to measure the SCF dimension (Table 3).

Table 3. Descriptive analysis—SCF items (N = 372).

Rank	Number of Contents	SCF (Chandak et al. 2021)	*Mean*	*S. D*	*Level*
1	7	Our company has the ability to deliver orders faster to customers leading to a better relationship with them.	4.22	0.79	High
2	6	Our company has the ability to change existing products and develop a number of new products annually and at affordable prices.	3.95	1.12	High
3	8	Our company has the necessary flexibility in order to meet a variety of customers and suppliers at the same time.	3.95	0.86	High
4	9	Our company has the ability to change and modify the features and specifications of new products.	3.93	0.91	High
5	10	Our company has the ability to manage different designs and uses various measurement units.	3.64	1.05	Moderate
		Total mean value	3.9392		High

SCC: According to Simatupang and Sridharan (2008), SCC is described as 'The process of independent firms (two or more organizations) working together throughout an SC to deliver products to end customers with the primary goal of maximizing long-term profit for all chain partners and achieving a competitive advantage'. Five items adopted from the Baah et al. (2021) scale have been used to measure SCC. Table 4 presents these items and their statistics.

Table 4. Descriptive analysis—SCC items (N = 372).

Rank	Number of Contents	SCC (Baah et al. 2021)	Mean	S. D	Level
1	14	Our company and partners in the supply chain exchange all relevant information accurately and in a timely manner.	3.9785	0.95707	High
2	13	Our company and supply chain partners have a range of agreements on improvements that benefit the entire supply network.	3.8817	0.84801	High
3	15	Our company and partners in the supply chain manage the stock forecast and demand cooperatively.	3.8468	1.06179	High
4	12	Our company and partners in the supply chain collaborate to obtain, absorb, and apply relevant knowledge for the benefit of all.	3.793	0.90083	High
5	11	Our company and supply chain partners share benefits and costs (such as saving inventory costs and loss when changing orders) resulting from participatory supply chain management.	2.9785	1.27153	Moderate
		Total mean value	3.6957		High

Second, for the dependent variable (operational performance), several references have been used to conceptualize this dimension (Kadhum et al. 2021; Khan et al. 2022; Hallgren and Olhager 2009). According to Hallgren and Olhager (2009), operational performance is concerned with measuring the degree of success of an organization in maximizing its benefit from the available resources, with a focus on several main aspects such as quality, cost, flexibility, and time (delivery). For this study, it is defined as the degree to which manufacturing companies in Jordan achieve the goals of quality, speed, and flexibility in a specific period of time in order to satisfy customers' needs and requirements. Eleven items have been adopted from Khan et al. (2022) and Kadhum et al. (2021)'s studies to measure this variable. Table 5 presents these eleven items and their descriptive statistics.

Table 5. Descriptive analysis—Operational performance items (N = 372).

Rank	Number of Contents	Operational Performance (Khan et al. 2022; Kadhum et al. 2021)	Mean	S. D	Level
1	10	Our company strives to get rid of all forms of waste (sources, time, space, energy...).	4.293	0.91566	High
2	1	Compared to our competitors, our company produces high-performance products that match customers' expectations and preferences.	4.2554	0.8221	High
3	3	Compared to our competitors, our company provides better and more affordable products.	4.2043	0.82494	High

Table 5. *Cont.*

Rank	Number of Contents	Operational Performance (Khan et al. 2022; Kadhum et al. 2021)	Mean	S. D	Level
4	8	Our company strives to manage and resolve customer complaints as quickly as possible.	4.1505	0.9567	High
5	4	Our company is working hard to ensure the optimal use of resources in order to reduce costs.	4.1909	0.84905	High
6	2	Compared to our competitors, our company can respond faster to changes in demand.	4.1317	0.70145	High
7	11	Compared to our competitors, our company has the ability to produce different products and make the same facilities and capabilities available.	4.0269	0.95974	High
8	6	Our company strives to achieve quality goals by reducing waste and loss of production.	3.9409	1.02358	High
9	9	Compared to our competitors, our company has advanced maintenance programs that prevent stopping work to a minimum to meet delivery times.	3.5806	1.13577	Moderate
10	7	Our company strives to apply different quality control methods (such as statistical, laboratory, etc.).	3.3065	1.28967	Moderate
11	5	Our company is working hard to apply the principle of recycling to reduce costs.	3.2796	1.34277	Moderate
		Total	3.9418	0.43554	High

Third, for the moderator variable (digital technologies), several references have been used to conceptualize this dimension (Ivanov et al. 2019; Eslami and Scholz 2021). According to Ivanov et al. (2019), digital technologies are defined as a group of interconnected smart technologies such as the IoT, big data, BDA, cloud computing, and electronic physical systems, which facilitate communication, integration, and automation in business processes. Five items adopted from Eslami and Scholz (2021) have been used to measure the moderating impact of digital technologies (Table 6).

Table 6. Digital technologies items.

Item Number	Item Description
	Digital Technologies (Eslami and Scholz 2021)
DT1	Our company uses advanced technical capabilities to integrate product development and manufacturing processes together through computer-based systems.
DT2	Our company uses advanced processes related to 4.0 Industry revolution technologies (3D-printing, big data, additional manufacturing, IoT, sensor techniques, virtual models, and cloud services).
DT3	Our company uses digital tools and technologies that detect breakdowns automatically, accurately, and simultaneously.
DT4	Our company is seriously transforming into one form of a "future factory" (such as a smart/digital factory and adaptive manufacturing systems).
DT5	Our company uses digital automation with sensors to determine the ideal operating conditions and schedule products tidily.

4.5. Instrument Validity and Reliability

First, content validity was checked after designing the instrument. This validity was used to ensure that the items of the questionnaire accurately measure the study variables. In addition to the English version, an Arabic copy of this questionnaire was also established to make it convenient for all of the respondents. Although all of the items the of the study tool were adapted from previously published studies, the content validity has been confirmed with the assistance of specialized academic staff for both the English and Arabic versions. A two-translation-stages approach has been implemented to ensure the accuracy of the translation and the consistency of the meanings in both versions. Finally, before starting the data collection process, the study tool received the approval of the Council of Research Ethics, Departmental of Scientific Research, Yarmouk University.

In terms of instrument reliability, this study uses the Cronbach's alpha coefficient The coefficient value (0.70) or more is considered acceptable to judge the stability of the resolution (Sekaran and Bougie 2016). Table 7 summarizes the Cronbach's alpha coefficient values.

Table 7. Cronbach alpha for instrument constructs.

Construct	Cronbach's Alpha Value
SCA	0.737
SCF	0.729
SCC	0.758
SCR	0.741
Operational performance	0.737
Digital technologies	0.777

According to Table 7, all of the Cronbach's alpha values were greater than (0.70), demonstrating a reasonable level of reliability for all of the constructs. Therefore, based on the calculated Cronbach alpha values, it can be stated that the instrument exhibited an acceptable reliability level.

4.6. Model Suitability for Subsequent Analysis

This section presents data relating to the normality assumption and multicollinearity check to support the model's suitability for further analysis. Given that the central limit theorem states that increasing the sample size causes the sample variance to become closer to the variance of its population, the sample distribution can be considered normal if the sample size exceeds (30) (Pallant 2020). Kurtosis compares the tail of the data to the normal distribution, whereas skewness indicates how far the data distribution deviates from the normal distribution. Adding the range of (±2.2) is the best-recommended range for kurtosis and skewness (Sekaran and Bougie 2016). Table 8 summarizes the Kolmogorov–Smirnov, skewness, and kurtosis tests' outcomes.

Table 8. Kurtosis and skewness values for study the constructs (N = 372).

Constructs	Kolmogorov–Smirnov		Skewness	Kurtosis
	Statistic	Sig.		
SCA	0.123	0.000	0.849	−0.672
SCF	0.141	0.000	−0.457	−0.194
SCC	0.100	0.000	−0.228	−0.220
SCR	0.052	0.000	−0.078	−0.325
Operational Performance	0.077	0.000	−0.428	0.735
Digital Technologies	0.100	0.000	−0.597	0.302

Although all of the Kolmogorov–Smirnov outcomes are significant, all of the variables in this study achieved acceptable values for both skewness and kurtosis that were less than the upper absolute limit of the suggested range exhibiting acceptable normality. For the multicollinearity issue, the independent variable (SCR) in this study, is an interconnected process with overlapping and interdependence between its steps. However, to avoid multicollinearity among these steps, it is necessary to ensure that each step of this process is measured by a different indicator. The interpretation coefficient (R^2), variance inflation factor (*VIF*) and tolerance were employed to detect any multicollinearity. Table 9 summarizes these values.

Table 9. Multicollinearity tests (N = 372).

Construct	Tolerance	VIF	Pearson Correlation		
			1	2	3
SCA	0.902	1.109	**1**		
SCF	0.892	1.121	−0.173	**1**	
SCC	0.970	1.031	−0.127	−0.293	**1**

According to Neter et al. (1996), tolerance values should be greater than (0.05) and the VIF should not be more than (10). Meanwhile, Pearson correlation values should not be greater than (0.90). Table 9 shows multicollinearity scores demonstrating that the SCR constructs do not have multicollinearity issues.

5. Results

To investigate the extent of the presence of targeted constructs to which this study was concerned in the targeted context to achieve the research objectives, and to test its hypotheses, several statistical tools are required. The first research objective does not require a complex testing hypotheses procedure; descriptive statistics can achieve the purpose in this regard. Therefore, descriptive statistics (mean and standard deviations) are utilized to answer the first study question. Meanwhile, research objectives 2 and 3 required more advanced analyses and testing tools.

5.1. Descriptive Statistics

To identify the implementation level for SCR and operational performance in Jordanian manufacturing firms, the descriptive statistics (mean and standard deviations) were computed for both the main and the sub-variable levels. At the aggregate level, the SCR dimension received a high level of evaluation (3.852). Additionally, all of the SCR constructs were evaluated as high too: 3.939, 3.921, and 3.695 for the SCA, SCF, and SCC, respectively. Considering that the mean values were in a high-level range, demonstrating that there is a positive attitude toward the SCR constructs; the respondents perceived that their firms highly employ SCR and their construct; there is a high consensus about this perception.

In addition to Table 1 that summarizes these descriptive outcomes, Tables 2–5 summarize the descriptive statistics for the SCR dimensions (SCA, SCF, and SCC) and the dependent variable (operational performance), respectively. For each construct, related items are arranged in descending order based on their mathematical means as follows:

SC agility: A descriptive analysis for SCA items is presented in Table 2. These results show that, according to the respondents' evaluations, the overall level for the SCA dimension is high (3.92) with a (0.563) standard deviation. Four items in the SCA dimension scored high levels, the practice related to *"Our supply chain responds quickly when introducing/entering new products to the market."* scored the highest agreement level (4.01). Whereas the practice related to *"Our supply chain responds quickly if improvements are made to the structure or performance of the chain"* scored the lowest mean value.

SCF: A descriptive analysis for the SCF items is presented in Table 3. The mean values ranged between (3.64) to (4.22). Four items of the SCF dimension scored high. The practice related to *"Our company has the ability to deliver orders faster to customers, leading to a better relationship with them"* was the highest mean value, and the practice related to *"Our company has the ability to handle different designs and uses various measurement units"* is the lowest one.

SCC: A descriptive analysis for the SCC items is presented in Table 4. The respondents reported that their firms highly employ SCC with a mean of (3.69). The highest mean value was for the practice related to *"Our company and supply chain partners exchange all relevant information accurately and in a timely manner"*, meanwhile the least mean value was for the practice related to *"Our company and supply chain partners share benefits and costs (such as inventory cost savings and loss when changing orders) resulting from participatory supply chain management"*.

Descriptive analysis for operational performance: According to Table 5, the surveyed firms have a high perceived level of their operational performance (3.941). The highest mean value (4.293) was for the item concerning *"Our company strives to get rid of all forms of waste (sources, time, space, energy)"*, whereas the practice related to *"Our company is working hard to apply the principle of recycling to reduce costs"* scored the lowest mean value (3.27).

5.2. Hypotheses Testing

In order to investigate the impact of SCR on the operational performance of Jordanian manufacturing firms for both the aggregate and sub-level, several regression tests were employed. At the aggregate level, the main first hypothesis (*H1*) was tested using simple linear regression. Additionally, the same approach was used to test the impact of the SCR constructs (SCA, SCF, and SCC) on the operational performance of each one alone. Table 10 summarizes the outcomes of these tests.

Table 10. Simple regression outcomes.

Variable	Beta Value (β)	R	R^2	F-Statistic	Sig. *	Decision
SCR	0.397	0.596	0.356	53.731	0.000	Supported
Constant	2.411				0.000	
SCA	0.151	0.616	0.38	14.680	0.000	Supported
Constant	3.350				0.000	
SCF	0.249	0.568	0.323	42.967	0.000	Supported
Constant	2.959				0.000	
SCC	0.152	0.663	0.44	16.925	0.000	Supported
Constant	3.380				0.000	
SCR	0.368		0.375	30.142	0.000	Supported
Digital technology	0.063				0.016	
Constant	2.34				0.000	
Dependent variable: Operational performance						

* Significant at the level ($\alpha \leq 0.05$).

H.1: *SCR is positively associated with the firms' operational performance.*

The results of the regression analysis are shown in Table 10. The model F statistic scored (53.731, $p = 0.000$). The correlation coefficient scored (r = 0.596) reporting a positive moderate to high correlation, demonstrating that whenever the level of SCR increases, operational performance increases too. With a rating of ($\beta = 0.397$, $p < 0.05$), it can be observed that SCR is positively associated with operational performance for Jordanian manufacturing firms. In addition, it was found that SCR explains a significant portion of the variance in the operational performance of Jordanian manufacturing firms ($R^2 = 0.356$; $p < 0.05$). This result confirms the hypothesis and thus the hypothesis is accepted.

H1.1: *SCA is positively associated with operational performance.*

The results of the regression analysis are shown in Table 10. It can be observed that SCA is positively associated with operational performance in Jordanian manufacturing firms, with ($\beta = 0.151$, $p < 0.05$) and F statistic scored (14.680, $p = 0.000$), demonstrating that for each unit increase in employing SCA, operational performance increases by (15.1%). In addition, it was found that SCA explains a significant portion of the variance in the operational performance of Jordanian manufacturing firms (R^2 = 0.38; $p < 0.05$). This result confirms the hypothesis and thus the hypothesis is accepted.

H1.2: *SCF has a significant positive impact on operational performance.*

The results of the regression analysis are shown in Table 10. From these results, it can be observed that SCF is positively associated with the operational performance of Jordanian manufacturing firms, with (β = 0.249, $p < 0.05$) and F statistic scored (42.967, $p = 0.000$), demonstrating that for each unit increase in employing SCF, operational performance increases by (24.9%). In addition, it was found that SCF explains a significant portion of the variance in the operational performance of Jordanian manufacturing firms (R^2 = 0.323; $p < 0.05$). This result confirms the hypothesis and thus the hypothesis is accepted.

H1.3: *SCC has a significant positive impact on operational performance*.

The results of the regression analysis are shown in Table 10. It can be observed that SCC is positively associated with the operational performance of Jordanian manufacturing firms, with (β = 0.152, $p < 0.05$) and F statistic scored (16.925, $p = 0.000$), demonstrating that for each unit increase in employing SCC, operational performance increases by (15.2%). In addition, it was found that SCC explains a significant portion of the variance in operational performance for Jordanian manufacturing firms (R^2 = 0.44; $p < 0.05$). This result confirms the hypothesis and thus the hypothesis is accepted.

H.2: *Digital technologies attenuate the link between SCR and operational performance*.

To test the moderating impact of digital technology on the SCR and operational performance relationship in Jordanian manufacturing firms, another regression test was employed. According to Table 10, the value of R^2 is 37.5%, which is a good value. The beta of the moderate variable is 0.063, the beta of the independent variable is equal to 0.368 and the value of the constant is 2.34 and all of them are statistically significant. Additionally, the interaction model has been employed, Table 11.

Table 11. Interaction—Moderate variable.

Model	Beta	R^2	Sign
Interaction	1.712	0.41	0.001

This model is used when an independent variable has a different effect on the outcome depending on the values of another independent variable. An interaction is a special property of three or more variables, where two or more variables interact to affect a third variable in a non-additive manner. The interaction model is depicted in the table. According to Table 11, the beta value (1.712) and R2 (0.41) are statistically significant (0.001), indicating that there is interaction and the moderate variable (digital technologies) has an influence on the model of the current study.

5.3. Sample Differences Analysis

The results in the descriptive analysis provided overall levels for assessments as provided by respondents; this section tests for significant differences in the overall assessments according to demographic characteristics. For this purpose, the one-way analysis of variance (ANOVA) test was used to compare the mean values of these different groups. Table 12 summarizes the value of these tests.

Table 12. ANOVA test outcomes—Demographics (N = 372).

Charac44teristic	Subset	N	Mean	Std.	F	Sig. *	Sig. Group
			Age				
SCR	Less than 25 years old	55	3.9091	0.35051	2.441	0.164	No sig. group
	From 25 years old to 35 years old	136	3.8858	0.39402			
	From 35 years old to 45 years	98	3.8544	0.38415			
	More than 45 years	83	3.7558	0.40582			
Operational performance	Less than 25 years old	55	3.9835	0.49084	0.479	0.983	No sig. group
	From 25 years old to 35 years old	136	3.9211	0.44492			
	From 35 years old to 45 years	98	3.9174	0.45466			
	More than 45 years	83	3.977	0.35404			
			Gender				
SCR	Male	241	3.8296	0.38786	2.256	0.134	No sig. group
	Female	131	3.8931	0.39290			
Operational performance	Male	241	3.9623	0.43813	1.509	0.220	
	Female	131	3.9042	0.42986			
			Academic qualification				
SCR	High school/diploma or less	99	3.8121	0.41550	0.553	0.646	No sig. group
	Intermediate diploma	105	3.8565	0.38738			
	Bachelor	123	3.8656	0.38477			
	Postgraduate	45	3.8919	0.35909			
Operational performance	High school/diploma or less	99	3.9871	0.41559	1.161	0.324	No sig. group
	Intermediate diploma	105	3.9290	0.45050			
	Bachelor	123	3.9520	0.41811			
	Postgraduate	45	3.8444	0.48518			
			Years of experience				
SCR	Less than 5 years	115	3.9345	0.37754	3.220	0.023	Less than 5 years. More than 15 years.
	From 5 to 10 years	123	3.8249	0.41426			
	From 11 to 15 years	72	3.8491	0.36274			
	More than 15 years	62	3.7559	0.37420			
Operational performance	Less than 5 years	115	3.9723	0.48944	2.411	0.067	No sig. group
	From 5 to 10 years	123	3.8603	0.43619			
	From 11 to 15 years	72	4.0177	0.39630			
	More than 15 years	62	3.9589	0.34712			

* Significant at the level ($\alpha \leq 0.05$).

Differences between the remaining characteristics were investigated using the ANOVA test. The results are gathered in Table 12 and reported that the ANOVA was insignificant for differences according to age, gender, and academic qualification. Hence, we can conclude that the respondents regardless of their age, gender, and academic qualification reported consistent responses, and therefore, their firms are highly employing SCR and have high levels of operational performance. Meanwhile, the ANOVA test reported significant differences according to years of experience. The posttest LSD Fisher was followed up to establish multiple comparisons and determine the source of differences and reported that respondents who have experienced less than 5 years or more than 15 years reported lower levels concerning SCR.

6. Discussion

Based on the study findings, Jordanian manufacturing firms have a high level of SCR and operational performance. Additionally, all of the SCR dimensions (SCA, SCF, and SCC) are in a high level too. These high percentages of SCR and operational performance in Jordanian manufacturing firms support their abilities to face different risks and SC disruptions. During the financial crisis, the Arab Spring, Syrian refugees, and the COVID-19 pandemic, the Jordanian economy has managed to survive, and the manufacturing firms are still viable (Singh 2020). According to Abeysekara et al. (2019), firms that pursue high SCR levels are likely to achieve a higher level of SCR in the future. On the other hand, many studies have focused on measuring the operational performance level in terms of cost and delivery only (e.g., Hallgren and Olhager 2009; Nawanir et al. 2013; Gaudenzi and Christopher 2016) and their results were inconsistent with other studies that followed the same approach (Santoso et al. 2022; Abdallah et al. 2014; Khan et al. 2022), whereas this study takes another perspective when it focuses on operational performance in terms of achieving a competitive advantage through effectiveness and quality.

In terms of the SCR–operational performance relationship, the study findings reported that SCR through its three dimensions (SCA, SCF, and SCC) has a positive significant correlation with operational performance. This means that resilient SCs contribute to improving the level of operational performance in Jordanian manufacturing firms in a positive way. This is a finding that is consistent with previous studies' outcomes that support the positive impact of SCR on operational performance within different contexts (Belhadi et al. 2021; Chowdhury et al. 2019) and inconsistent with others such as Kamalahmadi and Parast (2016); Yu et al. (2018); and Alkalha et al. (2021). However, according to Neureuther and Kenyon (2009), the environment and degree of product standardization issues are expected to affect this relationship. The higher investment in increasing resilience has been found to be worthwhile mainly for companies with customized goods and high relevance of customer loyalty but not for more standard products. Therefore, more studies are needed to understand the nature of the SCR–operational performance relationship within different sectors, economies, and contexts.

Although all of the SCR dimensions have a significant impact on the manufacturing firms' operational performance, SCF was the strongest construct ($\beta = 0.249$). Therefore, SCF Beta is better at measuring how large the SCR changes are in relation to operational performance. In terms of the degree of closeness between the SCR and the operational performance, SCC is the closest construct ($R^2 = 0.44$). Due to the highly uncertain work environment, SCF can improve mass production and build flexible and adaptive changes to match market requirements and fluctuations (Centobelli et al. 2020). The findings of this study are consistent with Yu et al. (2018) who argued that proactive flexibility and reactive flexibility can improve operational performance through sharing accurate information in a timely manner, and they are consistent with Khanuja and Jain (2021) who pointed out that SCF is a significant mediating factor between SC integration and SC performance and argued that when a firm is flexible in their SC, SC integration will have a better influence on SC performance.

Furthermore, the results of this study have indicated that SCA has a positive impact on the operational performance of Jordanian manufacturing firms. This result is consistent with Panahifar et al. (2018) and Panigrahi et al. (2022)'s studies when they indicated that SCA has a direct influence on a firm's operational performance. In addition, they recommended that manufacturing firms must emphasize the role of agility in the SC, especially in a volatile environment. Hence, the Jordanian manufacturing firms that suffered several SC disruptions during the last years need to emphasize the importance of SCA more as a crucial requirement to improve their SCR, performance, and therefore, viability.

In terms of SCC, the results of this study indicated that SCC has a direct positive impact on the operational performance of Jordanian manufacturing firms. According to Cao and Zhang (2011), a lack of SCC impacts the harmonization of the SC partners and hinders the development of the SC as a whole. In fact, in today's competitive business world, firms must work together with SC partners to ensure that their SCs are competitive and improve their SC performance (Routroy et al. 2018). This result is consistent with Shahbaz et al. (2018) who indicated that SCC has a significant effect in terms of information sharing and joint ventures and this is consistent with the results of the study by Mohammed Nassir alkasb et al. (2021) when they examined the relationship between SCC and operational performance through the moderate role of SC complexity. Their results revealed that information-sharing, goal congruence, and knowledge-sharing as the dimensions of SCC have a positive impact on operational performance in the industry sector.

For the digital technologies' moderating role, the findings of this study support the moderating impact of SC digital technologies on the SCR–operational performance relationship. According to Ivanov et al. 2019, digital technologies, in general., have not yet been effectively deployed to flexibly display potential scenarios through virtual reality simulations that may strengthen an agile response in order to immediately respond to disruptions. Bogner et al. (2016) found that the manufacturing firms that are deploying SC digital technologies not just for certain operations but throughout the entire SC are able to deal with disruptions in a better way. These results are consistent with Raji et al. (2020) who argued that to be more resilient in times of disruption, digital technologies including cloud applications and BDA are needed to find solutions for reducing lead times and therefore improving operational performance. However, these results are somehow inconsistent with Ivanov et al. (2019)'s results when suggesting that digital technologies have a positive impact on SCR as when there is a disruption in the SC through quickly modifying the SC, digital technologies have no effect on operational performance.

7. Implications, Limitations, and Future Research

Several theoretical and managerial contributions and implications can be derived from this study, and due to the research limitations, several future research areas can be suggested too.

7.1. Theoretical and Managerial Implications

At the theoretical level, the study contributes to the SCR literature by clarifying the impact of SCR and its dimensions (SCA, SCF, and SCC) on operational performance. Additionally, it determined the moderating influence of digital technologies on these relationships. Thereby, this study provides an overall depiction in the context of SCR with a special focus on digital technologies within the developing economies context.

The surveyed variables support a high level of operational performance. Therefore, the consequence of SCR and the moderating role of digital technology and their impact on operational performance within this specific setting has been tested and supported. This study recommends for manufacturing firms to invest more and apply relevant SC digital technologies due to their positive impact on the SCR–operational performance relationship. The surveyed population has high levels of SCR, SCA, SCF, and SCC, and this indicates the suitability of the surveyed sample to conduct this study and encourages managers within this sector to continue this approach. Based on the SCR dimensions' outcomes, more interest in improving SCR levels can effectively improve manufacturing SCs' readiness for different SC disruptions.

Surprisingly, the respondents with more than 15 years of experience presented lower levels of approval in terms of SCR and operational performance. Therefore, Jordanian manufacturing firms need to understand their point of view more to ensure the appropriate level of harmony and consensus among their managerial team.

7.2. Limitations and Future Research

This is a descriptive analytical study that investigates the SCR–operational performance relationship and how the use of digital technologies moderate this relationship in Jordanian manufacturing firms. Therefore, the study findings are related to this context only. Other Jordanian sectors and/or other countries may have different situations that need more investigation. Moreover, the data were collected based on a survey questionnaire that collected related managers' points of view, using different secondary measurable data that reflect the actual level of SCR, and their dimensions, and operational performance can add more insights about this crucial relationship. Future studies can take both experts' opinions and secondary quantitative data for several economic sectors and/or countries in a comparative mood. Moreover, using different data collection tools in a longitude approach can help to understand the SCR–operational performance interaction better. In terms of 'performance', more studies are needed to explore SCR's impact on other performance types such as SC performance, financial performance, and sustainable performance. Finally, based on the SCR literature, several factors rather than digital technologies are expected to moderate/mediate SCR–operational performance relationships, and they need to be investigated too. Future studies need to discover other factors that may play a role in achieving superb operational performance. Moreover, how the impact of SCR and digital technologies differs between upstream and downstream firms is another valuable area to be considered.

Author Contributions: Conceptualization, S.F.A. and R.A.M.; methodology, S.F.A. and R.A.M.; software, R.A.M.; validation, S.F.A. and R.A.M.; formal analysis, R.A.M.; investigation, R.A.M.; resources, S.F.A. and R.A.M.; data curation, R.A.M.; writing—original draft preparation, R.A.M.; writing—review and editing, S.F.A.; visualization; supervision; project administration; funding acquisition, S.F.A. All authors have read and agreed to the published version of the manuscript.

Funding: This study has been partially supported by Yarmouk University, The Deanship of Scientific Research and Graduate Studies.

Institutional Review Board Statement: This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The collected data used to support the findings of this study are available from the first author upon request. Saleh Alkhatib, saleh.f@yu.edu.jo.

Acknowledgments: The authors would like to express their appreciation for the editor and reviewers' valuable comments and very detailed remarks, which were of significant help to improve the quality of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

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