INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 11, Issue 12, (2021) E-ISSN: 2222-6990

Supply Chain Resilience: A Review and Research Direction

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v11-i12/11985 DOI:10.6007/IJARBSS/v11-i12/11985

Published Date: 28 December 2021

Abstract

Supply Chain Resilience (SCRES) has gradually concerned as an important strategy which recovers from supply chain disruptions (SCDs) in this globalization era. SCRES has gained popularity by academia and practitioners in recent years. This paper aims at identifying the potential research trends in the emerging area and to provide a future research platform for researchers and practitioners in supply chain (SC) industries through conducting a review of empirical study on SCRES. As such, a detailed literature review is conducted, classified and synthesized with the objective to propose the future study direction for SCRES. The review also investigates the research development of SCRES in developing and developed countries, with a focus on case studies related to supply chain risk management and operation management within manufacturing industries. Finding from the empirical research review suggests that there is limited studies done on exploring the adoption and implementation of SCRES strategies especially in developing countries, such as China. Therefore, this paper contributes to the literature of SCRES by outlining the SCRES adoption and implementation strategy, with the focus on China's manufacturing industries.

Keywords: Manufacturing Industries, Supply Chain Resilience, Supply Chain Disruption, Developing Countries, China

Introduction

Since the outbreak of COVID-19 in 2020, the transportation of people and commodities is hindered due to a lot of countries locked down cities and boundaries, countless firms and workplaces must close immediately because of the limitation of labor force and cargo, which lead to 86% SCDs in the whole of the world (Remko, 2020). In fact, SCs have been always suffering from various stresses before the COVID-19 virus. For example, the 2011 Japan's Tohoku earthquake and tsunami caused SCDs not only in Japan lead to great losses but also in other countries, such as many developed countries and regions (Reserve Bank of Australia, 2011), even spread out into all over the world manufacturing SC (Brennan, 2011). These disruptions make SCRES a key strategy of sustainability (Ivanov, 2021).

Study specifically regarding the definition of SCRES can be retrospected back to the early 20th century. Ponomarov and Holcomb (2009, p.131) defined SCRES as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function". Most scholars are believed that SCRES is a crucial measure to the success of firms and SCs (Hohenstein, et al., 2015; Soni, et al., 2014; Wieland and Wallenburg, 2013). SCRES' main purpose is to speedily restore from accident SCDs and resume or even be superior to SC's initial performance (Hohenstein, et al., 2015; Ponomarov and Holcomb, 2009, p.131). In the best of circumstances, firms could even gain corrival advantages if rebounding more rapidly and successfully than other competitors (Dubey, et al., 2021), and improve collaboration among SC partners (Soni, et al., 2014). A company could take relevant precautionary measures to alleviate loss raised by expected disruptions (Ivanov, et al., 2014). For example, a company might explore beforehand the risk elements that hazard its supply chain and detect its supply chains level of reflection to the investigated risk elements. Adopting could improve the SC's ability to handle unavoidable disruptions and keep SC robustness (Pettit, et al., 2010). However, for unavoidable risks, a company needs to prepare buffer resources in advance to improve its SC's initiative capability to cope with unexpected disruptions (Vugrin, et al., 2011).

The purpose of this research is to investigate a review of the development of SCRES literature in developed countries and developing countries. The paper also is conducted to identify the potential research field of problems relevant to the exploitation and implementation of SCRES strategies. Furthermore, the study will provide a general overview through previous works of literature. At the end of the paper, the study will propose the research direction framework.

Literature Review

Supply Chain Resilience (SCRES)

It is crucial to integrate resilient supply chain practices into the entire process of a firm's operational management not only short-term survival but also long-term competitiveness. Various definitions of SCRES exist in the literature. Accordingly, Caniato and Rice (2003) define resilience as an ability in the supply chain management to face unpredictable disruptions and recover regular situations or even better. According to Scholten, et al. (2014), the antecedents of SCRES are SC agility (SCA), SC collaboration (SCC), and SC robustness (SCR) respectively. Several scholars, like Mandal, et al. (2016) are indicated that SC (re-)engineering, agility, collaboration, and supply chain risk management (SCRM) culture are the formative factors of SCRES

In recent years, SCRES is obtaining more attention among academics and managers used to firm management and supply chain operation. Many scholars have evaluated the multidisciplinary and multidimensional nature of SCRES (Bhamra, et al., 2011; Ponomarov and Holcomb, 2009, p.131). The previous pieces of literature also indicated that lots of scholars have researched the strategies of SCRES resort and implementation in developed countries such as Germany, USA, Portuguese, UK, and Taiwan. Still, fewer researchers have evaluated the resilient strategies in developing countries.

Supply Chain Resilience in Developed Countries/Regions

Developed countries/regions can be a brief description as more superior development of countries/regions due to the certain features that include higher GDP, stronger tertiary and quaternary industry, and higher Human Development Index. Therefore, the speedy economic development, higher dependency among enterprises, and complexity of SC network lead to the enterprises of developed countries are indicated highly vulnerable to risks and disruptions. Most scholars contribute their research to explore the integration of resilience concept and supply chain management in developed countries.

In the research of Brandon-Jones, et al (2014) in the UK has explored the antecedent of SCRES and robustness through investigating manufacturing industries. They concluded that the ability of supply chain visibility improves SCRES and SCR due to supply chain connectivity and information sharing resources. Another study from the Netherlands by Scholten and Schilder (2015) sought to examine the relationship between SCC and SCRES in Netherlands food processing firms. This study proved that collaboration plays a role of mediating in potential endogeneity on SCRES through enhanced visibility, velocity, and flexibility. Nickel and Schliebener (2021) looked into the implementation and impact of SCRES practices under the COVID-19 pandemic in the German and Scandinavian automotive industry. In this study, the work proved that SCA measures, improved SCC and information sharing, and SCRM has a role of mitigation on bullwhip effect.

Through a study in Taiwan by Liu, et al (2018) explored the correlation of key SCRES ability effects and company performance based on the Taiwanese liner shipping industry. Based on PLS-SEM analysis, four SCRES measures were identified: SCRM culture, SCA, integration, and SC (re-)engineering. Meanwhile, Juan, et al. (2021) investigated the relationships among the five components of SCRES: SCC, visibility, velocity, flexibility, and SCR and their influence on the SC performance under disruptions by PLS-SEM analysis in Taiwan manufacturing firms. Furthermore, inspect the latent endogeneity of SCC by Two-stage least-squares (2SLS).

Moreover, a study from the USA carried out by Dickens, et al (2021) has constructed a theoretical SCRES model based on TCE and Panarchy theory by using SEM to analyze 15 industries in the US. This study verified that the impact of bouncing SCRES on firms during disruption back or forward. One study from the USA conducted by Li, et al. (2017) identified three key dimensions of SCRES: SC preparedness, SC alertness, and SCA, and reveal that the three dimensions have a significant influence on a company's financial performance. On the study of Spain, conducted by Ruiz-Benitez, et al (2019) evaluated the influence of lean and resilient practices on the economic, environmental and social performance by exploring they are applied to SCs by an Interpretive Structural Modeling (ISM) approach in the aerospace sector and found 12 practices identified from existing works of literature: use of information control systems; improve communication; flexible supply base; prepare redundancy; reciprocal contracts among enterprises of sc; increase coordination; keeping extra product ability; enforce security; emergency designing; disruption restore planning; multiple ways of transportation; visible transportation.

In addition, El Baz and Ruel (2021) examined the impact of SCRM on SCRES and robustness during the covid-19 pandemic in French enterprises. In this study, the work indicates that SCRM practices as a mediator enhance SCRES and robustness. Oh, et al. (2020) investigated

the relationship between information technology, relational competencies, SCC, and integration and their impact on operational performance under the covid-19 pandemic in Korean SMEs. The research develops a more resilient SC to deal with unpredictable events by evaluating critical factors of emergency management and operational performance. A study by Belhadi, et al. (2021) has explored resilience by sequential mixed-method and investigated response strategies of SCRES during short-period and long-period in automobile and airline firms. Besides, it also shows that the influence of the covid-19 outbreak on SC of manufacturing and service.

Supply Chain Resilience in Developing Countries

Less study focused on the development of SCRES in developing countries, particularly in the Asian area. The SCRES theory is relevant to the emerging theory in Asian Region and might only limit firms enabling meet circumstances to practice it.

The study of Tarigan, et al (2021) in Indonesia has analyzed the relationship between internal integration, SC partnership, SCA, SCRES, sustainable advantage. This finding demonstrates that SCRES strengthens sustainable advantage through offering real-time delivery and enough sales capacity in pandemic disruptions. Furthermore, the study also proved that SCRES play an important role of mediating in the association between internal integration and sustainable advantage. A study by Asamoah, et al (2020) in Ghana indicated that even though most scholars and managers pay attention to the concept of SCRES in recent years, empirical research exploring the formers and effects is still deficient, especially, based on small and medium enterprises (SMEs). The study analyzed that the impact of social network relationships and SCRES on customer-oriented performance by investigating 110 SMEs in Ghana.

The research from Pakistan, studied by Mubarik, et al (2021a), tested the relationships between the intellectual capital (IC) and SCRES by comparing the implementation level of IC through investigating 159 processed-food sector firms. Meanwhile, the paper also explores supply chain learning plays a crucial role of mediating among the three characteristics of IC and SCRES. Another study also by Mubarik, et al (2021b) identified the relationship between SC mapping, SC visibility, and SCRES in Malaysia. The research also confirmed SC visibility as a crucial mediator that directly impacts SC mapping and SCRES.

One study from India that has been carried out by Aggarwal, et al (2020) has examined the impact of collaboration on SCRES through empirical research of five SCs. Another study from India by Mandal, et al (2016) investigated the internal relations between four elements of SC capabilities and their impact on SCRES and SC performance. Besides, it also explored the influence of integrated logistics capabilities on SC capabilities. In this study, this research verified SCRES play an active role in SC performance. Rajesh (2017) evaluated the main technological capabilities of enterprises that impact SCRES capabilities using based on an Indian electronic manufacturing firm. On the basis of A total interpretive structural modeling (TISM) approach, 11 Technological capabilities of industries were identified.

The concept of SCRES is relatively newer in China. Previous research confirmed that remains inadequate scholar's research on the implementation of SCRES strategies in terms of China as a developing country. Besides, the components of SCRES measure still do not have a unified

standard. One study from China that has been carried out by Zhang, et al (2021) has proposed a theoretical framework of the elements impacting the SCRES of the prefabricated building (PB) in terms of SCRES management and indicated production and assembly construction of factors play a crucial role on SCRES of PB. However, the influence of transportation and storage is not obvious.

Gu, et al (2021) analyzed how enterprises adopt the exploitative of IT pattern and the explorative of IT pattern with SC partners to obtain the resilience of supplier and customer in terms of conceptual of information processing. In addition, it evaluates the relationship between the performance and SCRES based on manufacturing industries in China. The research has paid more attention to the resilience of supplier and customer respectively, which are generally recognized as external resilience. Furthermore, Ji, et al (2020) evaluated the impact of SCRES on green supplier integration and environmental performance. Meanwhile, knowledge combination as a moderator is crucial in the association between green supplier integration and SCRES. In the work, SCRES has measured two dimensions: proactive and reactive.

Review of Past Literature on Supply Chain Resilience

The following is a review of past studies on SCRES-related issues, grouped into three sections: Manufacturing (various industry), Manufacturing (focus industry), and China. Table 1 indicates prior researches on SCRES in various manufacturing industries. Lots of scholars used the manufacturing sector as the sample for their research to inspect the exploitation and implementation of SCRES in either developed or developing countries.

Table 1.
Articles on SCRES in manufacturing industry (Various Industry)

Author/Year	Summary	Country
El-Baz and Ruel (2021)	● As regards the combination of dynamic resources, explain the elemental doctrine of resource-based view and organizational information processing theories as to face the unpredictable disruptions. ● Explain the SCRM practices as a mediator between the SCRES and SCR, and the prominent role of fostering SCRES and SCR.	France
Juan, S.-J., et al., (2021)	● AS independent variables of SCRES, SCC has a direct impact on four elements and SCPUD. ● Only SC flexibility has a directly impact of SCPUD as the component of SC agility, and it not only is effected by SC velocity, but also can be indirectly effected by SC visibility through velocity. ● SC visibility has positive impact of SC robustness and SC velocity as vital variables of agility.	Taiwan
Dickens, J. M., et al., (2021)	● Resilience caused the companies to restore their pre-disruption situation after disruption. ● The stockholder should pay more attention to knowledge of ability to recuperate to the firm's preceding status under a disruption to avoid wasting resources in the long-term SC reorganization construct.	USA
Tarigan, et al., (2021)	● Internal integration through interdepartmental data sharing affects SC partnerships, SCA, and SCRES. ● SCA, SCRES and sustainable advantage by delivering materials real-time and responding to changing demand.	Indonesia
Oh, S., et al., (2020)	● The integration of supply chain systems was positively impacted by	Korea

	IT and relational competencies, relational competencies substantially effected on SC integration and SCC. ● Supply chain integration reinforced SCC, meanwhile, SCC has positively impact on contingency management.	
Asamoah, et al., 2020	● SCRES has mediator effect among social network relationship and customer-oriented performance.	Ghana
Aggarwal, S., et al., (2020)	● Explore and define SC collaborative resilience.	India
Li, X., et al., (2017)	● The significantly effect of the three dimensions of SCRES (i.e., preparedness, alertness, and agility) on the financial performance of firm. ● As proactive resilience capability, the impact of SC preparedness on corporate finance is more significant than that of reactive capabilities (alertness and agility).	USA
Mandal, S., et al., (2016)	● SCC and supply chain visibility are both positilively impacted by integrated logistics capabilities. ● To identify the four dimensions of SCRES (collaboration, flexibility, visibility, velocity) and influence each other.	India
Brandon-Jones, E., et al., (2014)	● SC visibility capabilities that results from SC connectivity and information sharing resources strengthen resilience and robustness.	UK

The entire supply chain may conclude with interruptions or declined capacity due to a disruption to any single node of the manufacturing supply chain, even influenced supply chain of the whole global manufacturing; in addition, the manufacturing industry continued to as an important contributor to the global economy in recent times. Hence, disruptions will cause serious economic wastage to the whole supply chain, moreover, the supply chain completely collapsed and never recovered from the disruption (Tukamuhabwa, et al., 2015). Thus, as a significant economic driver, the manufacturing industry squints towards be the potential sample of research because they are inclined to accomplish SCRES practices to recover from disruptions.

In the meantime, Table 2 also shows the past researches of SCRES in the manufacturing industry, however, it only studies the definite industries from the various kinds of industries. These scholars had focused on the specific industry to in-depth knowledge of SCRES rather than contrasting them to different industries.

Table 2.
Articles on SCRES in manufacturing industry (Focus Industry)

Author/Year	Summary	Country/Industry
Nickel, T. and J. Schliebener (2021)	● Although the results of the research explored that the disruption of COVID-19 caused a bullwhip effect, it is certain that yields will recover rapidly and rebound. ● Limitations on the use of technological innovation or sustainability.	Germany, Scandinavian; Automotive sector
Mubarik, M. S., et al., (2021)	● Supply chain mapping has positively impacts on supply chain visibility and SCRES. ● SC visibility plays a role of mediating between mapping and resilience.	Malaysia; Electrical and Electronics sector
Belhadi, A., et al., (2021)	● In the view of the automotive sector, developing localized sources of supply and using Industry 4.0 technologies is the best strategy for alleviating the risks linked with COVID-19. ● Cooperation among stakeholders is perceived, escalating digital technologies.	Europe, Asia, Africa; Automobile sector, Airline sector
Mubarik, M. S., et al., (2021)	● All of the IC's dimensions have impact on the corporation's SC learning and SC resilience. ● SC learning plays pivatal role in fortifying the influence of IC on SCRES.	Pakistan; Processed food industry
Ruiz-Benitez, R., et al., (2019)	● The lean practices serve as the drivers of the resilience practices, meanwhile there are collaborative effects each other. ● Lean practices and resilient practices affect sustainability performance by direct and indirect.	Spain; Aerospace sector
Liu, Chiung-Lin, et al., (2018)	● Risk management culture has significant and direct effect on agility, integration and SC (re)engineering. ● SCRM culture has positive effect on the enterprise perfomance. ● risk management performance has positive effects on the three types of SCR.	Taiwan; Liner shipping industry
Rajesh, R. (2017)	● Properly enhancing supply chain capabilities could reinforce flexibilities and improves resilience capabilities.	India; Electronic manufacturing industry
Scholten, K. and S. Schilder (2015)	● SCC is an antecedent of the constructs of SCRES. ● Competitors is one of determine factor of the level of SC resilience.	Netherlands; Food processing industry

Given the above discourse, a general opinion extracted out in the study is that the SCRES paradigm is crucial for firm's operational and supply chain management. However, the development of this field is still in the initial phases, with most of the articles published in the last ten years. This review guides the area for researchers and contributes to transparent paths for future research directions, especially for implementing the SCRES concept in the industry of automotive sector, Electrical and Electronics sector, Aerospace sector, and Food processing industry.

Based on Table 3, the past researches of SCRES in China manufacturing are studied. The table below presents clearly how many researchers bided to popularize this relatively new notion in China manufacturing. In recent years, the manufacturing industry has still made a huge contribution to the Chinese economy. According to the National Bureau of Statistics of China, the gross domestic product (GDP) growth was last reported at 2.3% by the manufacturing

sector, contributing 43.0% to the overall GDP in 2020. During the COVID-19 pandemic, the manufacturing industry is also one of the most affected sectors. As a matter of fact, the manufacturing economy increased by 1% year-on-year in China 2020, moderating from 1.9% in 2019, showing a sharp decline due to the disruption of COVID-19. Because China is a manufacturing center, it resulted in disruption of the global supply chain, and almost all sectors which are ranging from pharmaceuticals to automobiles are affected.

Likewise, most global companies were severely impacted by the Tianjin port explosions, especially the automotive industry, which was dealt hardest (Millar 2015). A ripple effect is caused by such supply chain disruption risk and leads to a decline of performance in terms of firm earning, service level, and productivity reduction (Dolgui et al., 2019). Therefore, the Chinese manufacturing industry needs to adopt SCRES strategies to mitigate SC disruptive risk (Kleindorfer and Saad 2005, Simangunsong et al., 2012). Hence, the study must investigate the level of adoption and implementation of SCRES among manufacturing companies in China.

Table 3.
Articles on SCRES in China

Author/Year	Findings	Area
Ji, L., et al., (2020)	● Supply chain resilience is positively influenced by green supplier integration on both the pro-activity dimension and the reactivity dimension. ● Green supplier integration effect environmental performance through the proactive and reactive dimensions of SCRES.	China; Manufacturing
Gu, M., et al., (2021)	● Only explorative of IT has outstanding impacts on achieving supplier and customer resilience, and these two aspects of SC resilience can enhance SC performance.	China; Automotive, Electronic,
Zhang, M., et al., (2021)	● PBSC (prefabricated buildings supply chain) resilience is significantly impacted by component production and assembly construction, which is no significantly impacted by transportation process and storage of components.	China; Prefabricated building industry

Based on these tables, the researchers can figure out that most of the empirical works were researched in developed countries, especially in the European Union and the USA, and paid more attention to the large manufacturing enterprises. It can be concluded that most developed countries as a sample to study because of the high frequency of disruption risks due to the complexity of supply chain networks, globalization, and natural disasters. Thus, it is regarded as that the manufacturing industry is the primary contributor to disruptions of the supply chain.

Research Direction

SCRES is gradually to be a popular research topic among scholars and managers. However, there is remains a lack of researches to explore the development of SCRES exploitation and implementation in terms of developing countries. Hence, the future study field will be paying attention to SMEs in the context of China due to spreading the research regarding SCRES in more depth. Small and medium-sized enterprises will be focused because they are the organization that has always been neglected thus far. The opinion has been supported by the

research of Tukamuhabwa, et al. (2015). Given the above discourse, the study direction of this paper is presented in Figure 1.

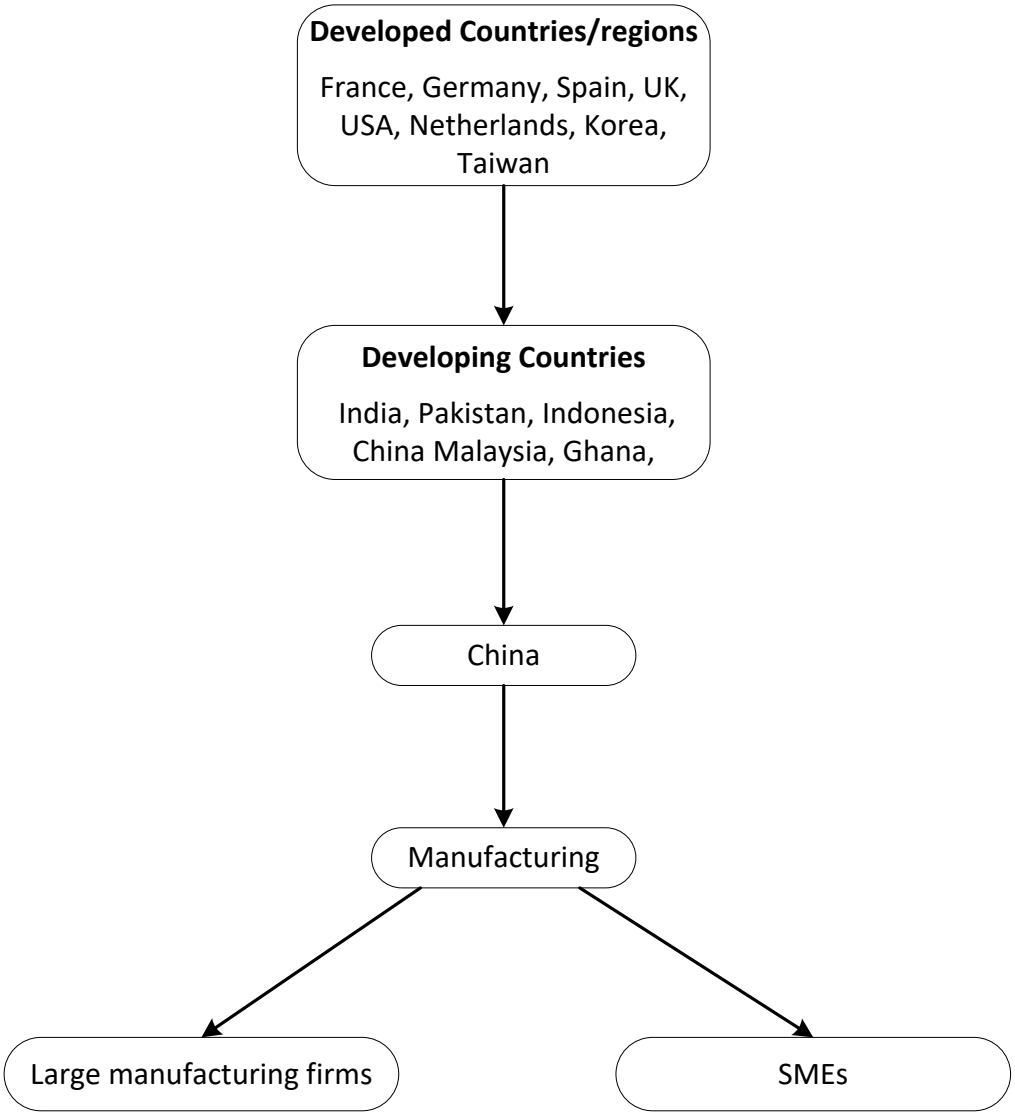

Figure 1. The framework of research direction

Conclusion

The study aims to review the previous literature in terms of SCRES development from the perspective of developed countries and developing countries. Even though some articles in the literature discussed the SCRES implementation includes definition, antecedents, principles, and performance in the entire globe, there has to remain a limited study about the SCRES implementation and exploitation in developing countries particularly China. Future research is still required for more concern about the exploitation and implementation of SCRES and also the firm consciousness level on operation performance and supply chain management due to unpredicted disruption.

Acknowledgements

This work was supported/funded by the Ministry of Higher Education under Fundamental Research Grant Scheme (FRGS/1/2019/SS03/UTM/02/8).

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