Empirical research on performance effects of supply chain resilience: systematic literature review, citation network analysis and future research directions

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Abstract: Although firms are aware of the importance of implementing various strategies of supply chain resilience (SCRES) to mitigate and manage supply chain risks and disruptions, there are limited insights into the interrelationships among the strategies in affecting business performance. This study objectively reviews 135 articles related to the performance effects of SCRES through conducting a systematic literature review (SLR) and citation network analysis (CNA). Based on the results of the CNA, we identify citation network clusters of the articles with three main strategies of SCRES, namely, supply chain (SC) agility, SC risk management, and SC reengineering. A structured framework is developed to map the performance impact of SCRES strategies and the interrelationships between the two. Observing the common grounds and mutual citations among clusters, we propose research directions of the performance impact of SCRES based on the complex adaptive system (CAS) theory for advancing research on SCRES.

Keywords: supply chain resilience; SCRES; firm performance; systematic literature review; SLR; citation network analysis; CNA; resilient supply chain; complex adaptive system; CAS.

Reference to this paper should be made as follows: Li, C.S., Wong, C.W.Y., Wong, C.Y., Boon-itt, S. and Miao, X. (xxxx) 'Empirical research on performance effects of supply chain resilience: systematic literature review, citation network analysis and future research directions', *Int. J. Shipping and Transport Logistics*, Vol. X, No. Y, pp.xxx–xxx.

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1 Introduction

Supply chain resilience (SCRES) is generally defined as the adaptive capability of a supply chain (SC) to prepare for, respond to and recover from disruptions or unexpected events (Hohenstein et al., 2015; Ponomarov and Holcomb, 2009). SCRES has become an important means for business continuity and sustainability due to the increasing frequency and the damaging effect of SC disruptions in recent years (Lorenc and Kuznar, 2021). For example, JD.com, a largest e-commerce company in China, handled SC disruptions due to the COVID-19 by means of practical SCRES strategies, such as high levels of operational flexibility, agility, collaboration and information sharing, thus improving its SC performance (Shen and Sun, 2021).

As shown in Table 1, recent reviews of the SCRES literature contribute to the conceptualisation, enablers and characteristics of SCRES (e.g., Al Naimi et al., 2021; Novak et al., 2021; Shekarian and Mellat Parast, 2021) and the application of modelling or quantitative methods (e.g., Golan et al., 2021; Hosseini et al., 2019). However, the effectiveness of SCRES in achieving operational and economic performances is a major concern of business managers (e.g., Gligor et al., 2015; Shin et al., 2015). Since the 2000s, there are studies on SCRES and its performance effects (e.g., Kochan and Nowicki, 2018; Wong et al., 2020), suggesting the need for a systematic review on the performance impact of SCRES.

Existing studies on the performance impact of SCRES are fragmented. They tend to focus on the somewhat related strategies of SCRES independently (Blackhurst et al., 2011), such as integration (e.g. Lam, 2013; Liu and Lee, 2018), risk management (e.g. Kern et al., 2012; Kirilmaz and Erol, 2017), (re)engineering (e.g. Rudolf and Spinler, 2018), flexibility (e.g. Jia and Yang, 2020; Yu et al., 2018), and agility (e.g. Tarafdar and Qrunfleh, 2017), hindering an understanding of where the literature is situated and what to study next. Limited insights into how the knowledge is developed, borrowed, and extended among them are available. Past and recent reviews of SCRES literature contribute to the ambiguous definition and strategies of SCRES (e.g., Hohenstein et al., 2015; Hosseini et al., 2019; Kochan and Nowicki, 2018). To achieve a well-grounded, unified, and more holistic understanding of SCRES, efforts are needed to consolidate the abundant empirical evidence on the performance effects of the different strategies of SCRES. Thus, the following research questions are proposed:

Table 1 Summary of recent reviews on SCRES

Article	*Methodology*	*Searching Database*	*Searching keywords*	*No. of articles*	*Focus*	*Contribution*
Al Naimi et al. (2021)	Systematic mapping review	Web of science, scopus	‘Supply chain’, resilient*, enabler*, approach*, capability*, reconfigured*, characteristics, attributes, component	286	SCRES and reconfiguration	Enablers of SCRES and characteristics of SC reconfiguration
Golan et al. (2021)	Systematic literature review	Web of science	‘Supply chain*’, vaccine*, resilient*, COVID*, pandemic, manufacture*, model*	145	Modelling SCRES	Resilience analytics in vaccine SCs
Han et al. (2020)	Systematic literature review	Emerald, science direct, ABI/ Inform, Taylor and Francis, Wiley Online	‘Supply chain’, resilient*, measurement, performance, assess, indices, capabilities	153	Capabilities and performance metrics of SCRES	SCRES capabilities-performance metrics framework
Senna et al. (2021)	Systematic literature review	Web of science, scopus	‘Supply chain risk management’, SCRM, risk, ‘supply chain 4.0’, ‘internet of things’, IoT, healthcare, warehouse, procurement	26	Healthcare SCRES	Constructs of SC performance and healthcare SCRES
Shekarian and Mellat Parast (2021)	Systematic literature review	Emerald, Elsevier Science Direct, ABI/Inform Global ProQuest, Wiley, INFORMS, Google Scholars, Springer, Taylor and Francis Online	‘Supply chain’, flexible*, agil*, redundant*, collaborate*, cooperate*, disruption, uncertain, risk, resilient*	98	SCRES enhancers and SC disruptions	Impact of various resilience enhancers on mitigating different types of SC disruptions
Spieske and Birkel (2021)	Systematic literature review	Web of Science, Scopus, EBSCO	‘Supply chain’, risk, resilience, disruption, ‘industry 4.0’, digital, cloud, blockchain, cyber-physical, ‘additive manufacturing’, ‘artificial intelligence’, ‘big data’, ‘data analytics’, ‘internet of things’, ‘machine learning’	62	The link between Industry 4.0 and SCRES	Big data analytics is suitable to enhance SCRES, but other industry 4.0 enabler technologies still lack proof of effectiveness
This study	Systematic literature review and citation network analysis	Web of Science, EBSCO, Google Scholar, JSTOR, ProQuest, and Scopus	‘Supply chain*’, flexible*, complex*, vulnerable*, risk*, agil*, resilient*, uncertain*, disrupt*, safe*, mitigat*, robust*, secure*, performance, data, test*, empirical, statistical, finding*, result*, evidence	135	Empirical studies on performance impact of SCRES	Identification of main strategies of SCRES, research directions of the performance impact of SCRES based on the CAS theory

RQ1 How is the knowledge on SCRES-performance developed, borrowed, and extended in the largely fragmented literature?

RQ2 How future research can help to integrate the extant knowledge on SCRES-performance to make the literature be less fragmented?

Complex adaptive system (CAS) theory is applied to explore the network of the SCRES-performance literature and guide future research to enhance the linkages among different research attributes of SCRES. The CAS theory suggests that firms constantly adapt to a changing environment that is often uncontrollable by firms (Choi et al., 2001). It is applicable to explain how SCRES is adopted to handle SC disruptions and uncertainties in business operations (Liu et al., 2014; Ponomarov and Holcomb, 2009). The CAS theory can also be used to explain the connections among the independent agents in a structured complex system and their interactions (Choi et al., 2001). It provides an explanation on the importance of the connectivity among the SC partners and their activities in affecting the performance outcomes of SCRES (Ponomarov and Holcomb, 2009). Furthermore, the CAS theory advocates that firms often create an emergent adaptive system with their dynamic learning ability and evolution by interacting with the external environment (Choi et al., 2001). This helps to explain how SCRES enhances the capacity of an SC for operations continuity when the SC adapts to the changing environment (Ponomarov and Holcomb, 2009).

This paper contributes to the literature and practice in three ways. First, this study complements the systematic literature review (SLR) with the use of a citation network analysis (CNA) to objectively classify distinct research areas, observe their evolution and develop their knowledge structures that contribute to theory-building of SCRES based on the citations among the sample. Second, from the CAS perspective, future research directions are provided for advancing knowledge on the performance impact of SCRES through analysing how the knowledge regarding performance impact is transmitted from one strategy to others. Third, this study is a valuable reference for managers on the adoption of strategies in their firms to build SCRES to improve firm performance.

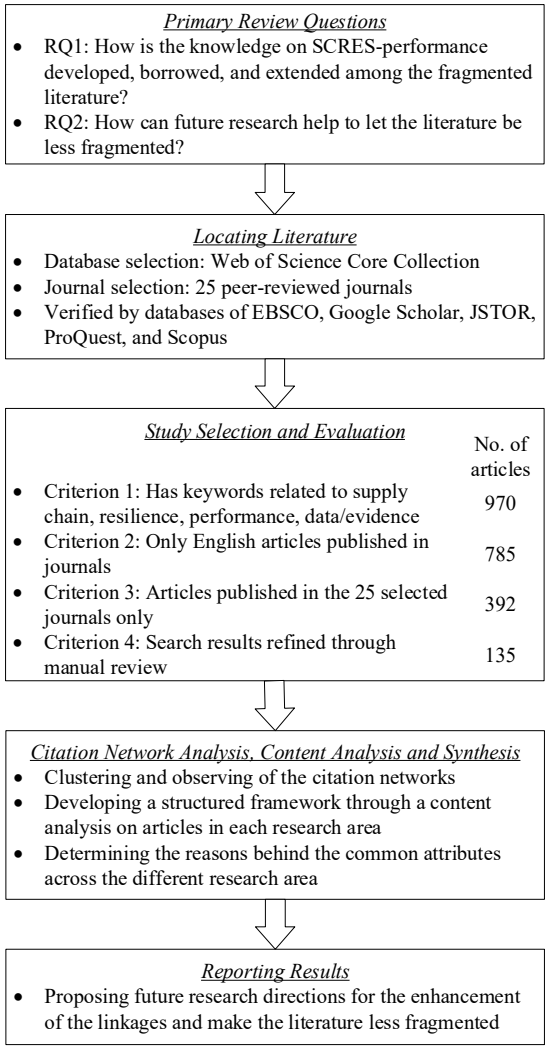
2 Research methodology

This study reviews the performance effects of SCRES through a SLR and CNA of the extent literature (Colicchia and Strozzi, 2012; Denyer and Tranfield, 2009; Tranfield et al., 2003), as depicted in Figure 1. The SLR helps to clarify inconsistent results on the relationship between SCRES and firm performance as reported by existing studies. By identifying the strategies of SCRES that might have a significantly positive relationship (De Giovanni et al., 2013; Li et al., 2015) and insignificant results (Gligor et al., 2015; Shin et al., 2015), the SLR provides the basis for future research to further investigate the performance impacts of SCRES (e.g., Cantor et al., 2014; Hohenstein et al., 2015).

The study introduces several extensions to the SLR method. A SLR reduces bias and increases objectivity while searching, selecting and reviewing the existing literature. We complement the SLR by applying a CNA. The CNA helps to identify distinct research areas or communities, and existing articles that cite each other by using the Girvan-Newman (GN) algorithm (Girvan and Newman, 2002; Newman and Girvan, 2004; Tong et al., 2019). The CNA provides an understanding of the dynamic evolution of each research area, which serves as a platform for developing future research agendas.

The CNA integrates fragmented studies by establishing connections between the strategies of SCRES and their performance effects across different research areas, and thus complements the SLR by eliminating subjective judgement while relating research articles.

Figure 1 Procedures of systematic literature review and citation network analysis



We searched for articles related to the theme of this study from the web of science core collection based on each progressive criterion (see Figure 1).

2.1 Main keywords

First, we identified keywords related to 'SC disruption' and 'SCRES' from the literature, including risk*, flexib*, complex*, agil*, vulnerabl*, resilien*, uncertain*, disrupt*, mitigat*, robust*, safe*, and secur*. Keywords related to 'SC disruption' were included to find out strategies of SCRES that are adopted to handle SC disruptions but named as terms other than what we selected. Second, we selected articles based on keywords related 'performance'. In this study, we focused on firm's business performance including operational performance and financial performance (Venkatraman and Ramanujam, 1986). Third, to select articles that contain data and evidence, we limited the search results by adding keywords i.e., 'data OR empirical OR test* OR statistical OR finding∗ OR result∗ OR evidence' (Newbert, 2007). 970 articles were obtained through 'advanced search' of web of science

2.2 Language and scholarly

To ensure the quality of the selected articles, we only used 785 journal articles, and excluded conference papers, books, etc., published in English

2.3 Quality journals

We include journals used in previous review papers in the field of SC management (SCM) (e.g., Igarashi et al., 2013; Martinez-Jurado and Moyano-Fuentes, 2014; Nakano and Akikawa, 2014). The aim here is to be comprehensive and inclusive, and therefore we selected as many peer-reviewed academic journals as possible. To ensure that influential journals in the field of SCM are taken into consideration, we verified their citation index and journal ranking on Thomas Reuters (Seuring and Gold, 2012). Finally, 25 journals comprised the sample for the study, as listed in Table 2. In this study, only the 392 articles published in the selected journals were used

2.4 Manual review

To further refine the search results, we followed prior research (e.g., Newbert, 2007) and eliminated articles that do not fit the theme (i.e., performance effects of SCRES) and do not fulfil the criteria listed above through reading through the abstracts, and then examined full texts to ensure their suitability and relevance. This resulted in 135 articles which were reviewed and analysed by using a CNA <see Supplementary I for the list of the selected articles>.

We conducted the search process based on the progressive criteria with no timespan limit on January 2, 2020. The selected articles from Web of Science Core Collection were validated by using other databases, i.e., EBSCO, Google Scholar, JSTOR, ProQuest, and Scopus, to enhance the face validity. These efforts grow our confidence in the results that no peer-reviewed articles related to the performance effect of SCRES are neglected in this study.

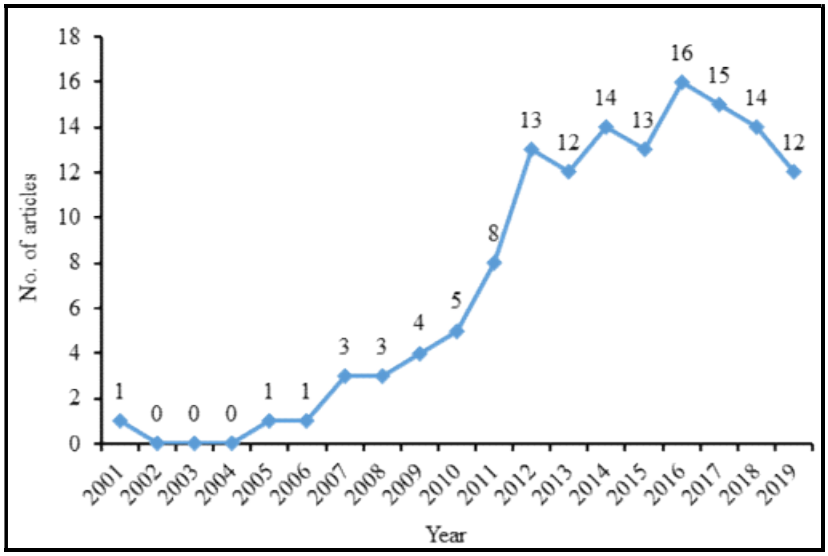
Table 2 Selected journals and article distribution in this study

No.	*Journal name*	*Abbreviation*	*No. of article(s)*	*Percentage*
1	Decision Sciences	DS	5	3.70%
2	Environmental Science and Technology	EST	0 [a]	0.00%
3	European Journal of Operational Research	EJOR	2	1.48%
4	Interfaces	Interfaces	0 [a]	0.00%
5	International Journal of Logistics Management	IJLM	14	10.37%
6	International Journal of Logistics: Research and Application	IJLRA	2	1.48%
7	International Journal of Operations and Production Management	IJOPM	16	11.85%
8	International Journal of Physical Distribution and Logistics Management	IJPDLM	6	4.44%
9	International Journal of Production Economics	IJPE	24	17.78%
10	International Journal of Production Research	IJPR	18	13.33%
11	Journal of Business Logistics	JBL	5	3.70%
12	Journal of Cleaner Production	JCP	1	0.74%
13	Journal of Environmental Management	JEM	0 [a]	0.00%
14	Journal of Operations Management	JOM	10	7.41%
15	Journal of Purchasing and Supply Management	JPSM	3	2.22%
16	Journal of Supply Chain Management	JSCM	1	0.74%
17	Journal of the Operational Research Society	JORS	0[a]	0.00%
18	Management Science	MS	0 [a]	0.00%
19	Manufacturing and Service Operations Management	MSOM	0 [a]	0.00%
20	Omega	Omega	2	1.48%
21	Operations Research	OR	0 [a]	0.00%
22	Production and Operations Management	POM	0 [a]	0.00%
23	Safety Science	SS	0 [a]	0.00%
24	Supply Chain Management: An International Journal	SCMIJ	24	17.78%
25	Transportation Research Part E: Logistics Transportation Review	TRLTR	2	1.48%
		TOTAL	135	100.00%

Note: [a] No article was selected from the corresponding journals.

Figure 2 illustrates an increasing interest in examining performance effects of SCRES. Although the first article was published in IJOPM in 2001, there was a gap in the following three years (i.e., 2002-2004). Most articles published after 2004, and the number is steadily increased during 2007-2010. With a dramatic increase in 2011 and 2012, the growth in interest continued with more than 12 articles published in the years after 2012. More than three quarter (80.74%) of the articles were published in the last seven years (109 articles). Six journals constitute a large share of the articles (78.52%), where 24 (17.78%) articles are from the IJPE, 24 (17.78%) from the SCMIJ, 18 (13.33%) from IJPR, 16 (11.85%) from IJOPM, 14 (10.37%) from IJLM, and 10 (7.41%) from JOM in 2001-2019 (See Table 2).

Figure 2 The distribution of articles according to year of publication (see online version for colours)



3 Citation network analysis and results

3.1 Construction of binary matrix

Following Wasserman and Faust (1994), we adopted a commonly used method for preparing the data for network analysis. Based on the records of the citations and reference data of the selected articles, we constructed a binary matrix, in which a value of '1' means that one article in the columns cites another in the rows and '0' means there is no citation relationship. Thus, one 135 × 135 matrix was developed.

3.2 Givan-Newman (GN) algorithm

GN algorithm aims to outline solid community structures by progressively removing edges that are loosely connected in a network (Newman and Girvan, 2004), which is

commonly adopted in CNA (e.g., Fan et al., 2014; Tong et al., 2019). In a citation network, a community can be categorised through maximising density within the community and minimising connections with other communities (Tong et al., 2019). If the network can be divided into m communities, another m × m matrix can be defined and its entry e_{ij} is the ratio of the links in the original network between the vertices in community i and those in community j. Therefore,

$$eij = \begin{cases} \dfrac{\sum_{v'\in V_i}\sum_{w'\in V_w} av'w'}{\frac{1}{2}\sum_{v\in V}\sum_{w'\in V_w} avw} & i \neq j \\ \dfrac{\sum_{v'\in V_i}\sum_{w'\in V_w} av'w'}{\frac{1}{2}\sum_{v\in V}\sum_{w'\in V_w} avw} & i = j \end{cases} \tag{1}$$

where V denotes the set of vertices in the original network and V_i is the set of vertices in community i. av'w' and avw are the entries in the matrix of the original network, and generally,

$$a_{vw} = \begin{cases} 1 \ \textit{if verticle v connects with w} \\ 0 \ \textit{if verticle v unconnects with w} \end{cases} \tag{2}$$

As Newman and Girvan (2004) demonstrated, the modularity is:

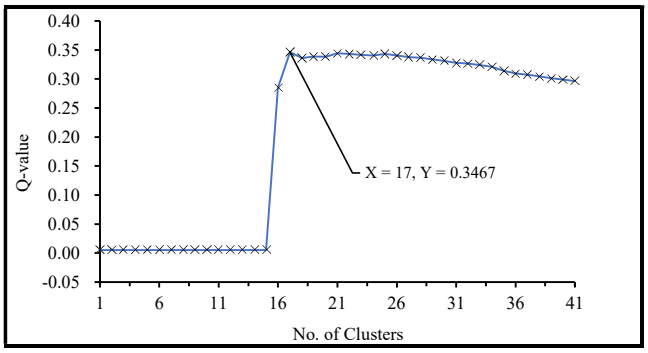
$$Q = \sum_{i=1}^{m}\left[e_{ii} - \left(\sum_{j=1}^{m} e_{ij}\right)^2 \right] \tag{3}$$

A large Q value indicates a strong community structure in the network. The range of the Q values for such networks is usually from 0.3 to 0.7 (Newman and Girvan, 2004). In this study, we calculate the value of Q and map the clusters with Ucinet 6 (Borgatti et al., 2002; Pilkington and Fitzgerald, 2006). Figure 3(a) shows the optimal Q-values, where Q_{max} = 0.3467 with 16 clusters, while Figure 3(b) shows the clustering results <see Supplementary I for the results of classification of selected articles>.

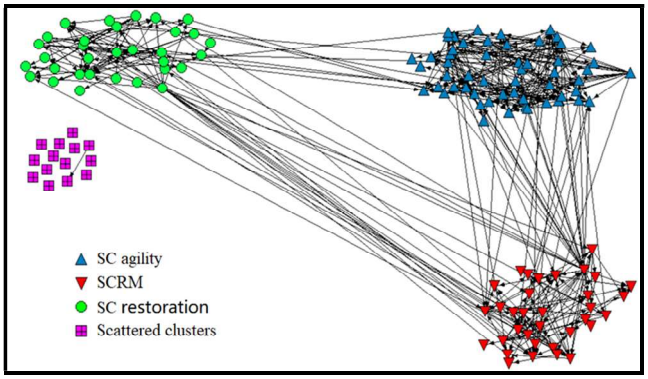
We reviewed the clusters and found that 14 of them only contained one article, i.e., 14 articles (10.37%). Therefore, we grouped and categorised them as 'scattered clusters' to visualise and discuss conveniently. The 14 articles in the scattered clusters are standalone without any linkage with other clusters, indicating that those articles do not cite or are not cited by articles from other clusters. The remaining three clusters consisted of 121 articles (89.63%). After reviewing the articles in each cluster, we labelled each cluster based on the common themes <see the column of Strategies of SCRES in Supplementary 2 for research themes of the articles> listed as elements of SCRES in previous studies (e.g., Christopher and Peck, 2004; Hohenstein et al., 2015): SC agility, SC risk management (SCRM) and SC restoration. SC agility is the most popular topic with 55 publications (40.74%), followed by SCRM with 34 articles (25.19%), and SC restoration with 32 articles (23.70%). Based on the literature, SC agility aims to enhance the ability of SCs to respond to disruptions timely with less impact when disruptions happen (Chan et al., 2017; Gligor et al., 2015); SCRM strengthens the readiness and rapidity of SCs for mitigating disruption risks (Kilubi and Rogers, 2018; Thun and Hoenig, 2011); while the adoption of SC restoration allows SCs to return to

original or more desirable supply operations after being disrupted (Al Naimi et al., 2021; Dowty and Wallace, 2010). These clusters allowed us to understand the impacts of the various strategies of SCRES on firm performance from the perspectives of the research areas.

Figure 3 (a) Q-value based on GN clustering method and (b) clustering results (see online version for colours)



(a)



(b)

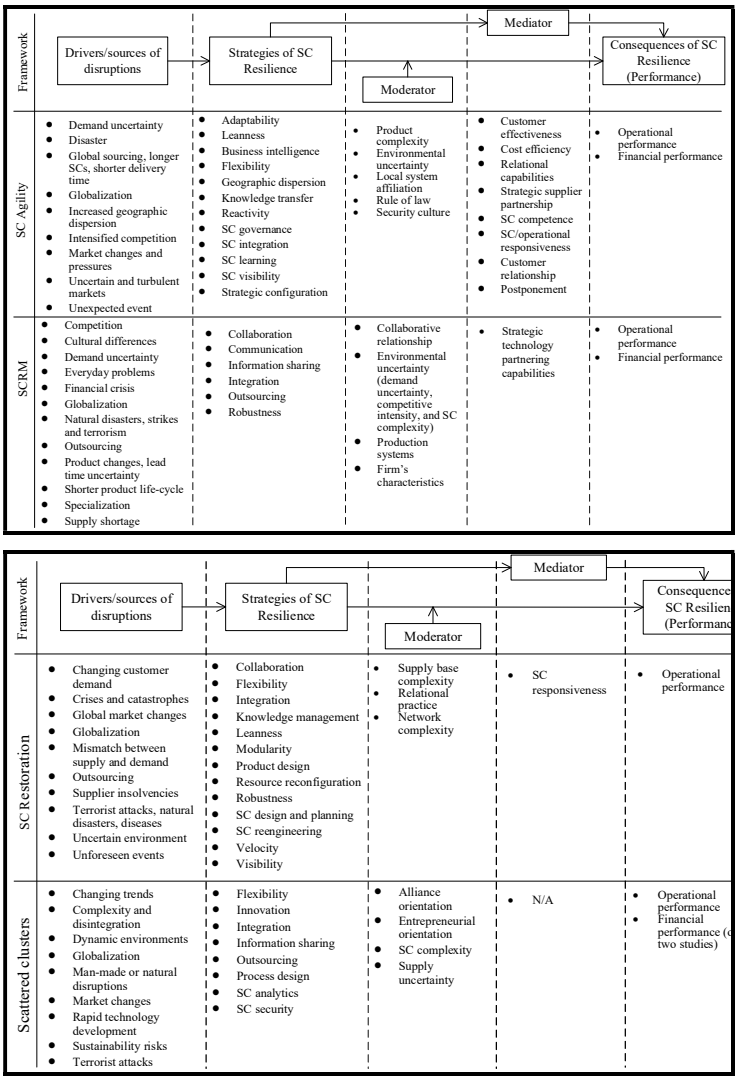
Furthermore, we observed the interactions between the clusters. Only nine linkages exist between SC agility and SC restoration, while the SC agility and SCRM clusters are more highly interrelated, compared to their citation links with SC restoration. Among the 30 linkages, seven articles with 11 linkages on SC agility are cited in SCRM articles while five articles with 19 linkages on SCRM are cited in SC agility articles. Thus, there is a warrant for a closer look.

4 Study findings

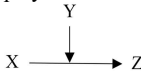
Through SLR, we reviewed the sample articles and formatted a summary table through a content analysis on articles in each research area <see Supplementary II for details>, providing the basis of our study findings. Based on the summary table, Figure 4 summarises the drivers/sources of the disruptions, SCRES strategies and their effects, and

the moderators and mediators in a structured framework. Among the selected articles, only two (i.e., Gligor, 2016; Kauppi et al., 2016) found a negative relationship between SCRES and firm performance, and others indicated the usefulness of the implementation of the SCRES strategies in achieving better performance outcomes.

Figure 4 Summary of literature in accordance with clusters[1]



Notes: The moderators and mediators were identified from the original articles that we selected. In the model 'A→B→C', B plays a mediator. In the model as follows, Y plays a moderator.



4.1 Performance effect in accordance with clusters

4.1.1 Performance effect of supply chain agility

Agility, flexibility and leanness are three attributes that have been directly related to financial performance, e.g., return on assets (ROA), return on investment (ROI) (Qi et al., 2011; Qrunfleh and Tarafdar, 2013; Sanchez and Perez, 2005). They require integration, adaptability (Eckstein et al., 2015), intelligence, knowledge (Blome et al., 2014) and reactivity. However, the performance effects of SC agility cannot be fully understood without considering different contexts. As shown in Figure 4, the literature examines how the contexts affect operational (e.g., customer loyalty, delivery, quality) and financial performances (e.g., ROA, ROI). Moderators (e.g., complexities and environmental uncertainties, local system affiliation, and security culture) and mediators (e.g., customer effectiveness, cost efficiency, postponement, customer relationship, and strategic supplier partnerships) have been identified. For example, several studies (e.g., Gligor et al., 2015; Qi et al., 2011) have examined the moderating role of the different dimensions of environmental uncertainty such as demand uncertainty, competitive intensity, SC complexity, and environmental munificence, dynamism and complexity. Although they all found that environmental uncertainty positively moderates the relationship between SC agility and firm performance, environmental uncertainty is conceptualised differently.

4.1.2 Performance effect of supply chain risk management

Most of the studies in the SCRM cluster focus on the impact of SCRM on operational performance (service, effectiveness, delivery, etc.). Only one (i.e., Li et al., 2015) measures the financial performance due to SCRM by using subjective measures of financial performance of others, calling for more studies on the impact of SCRES on financial performance. As summarised in Figure 4, previous SCRM studies have investigated the moderating roles of collaborative relationship (Li et al., 2015), environmental uncertainty (Liu et al., 2012), production systems (Shou et al., 2018), and characteristics of firms (Song et al., 2019), but only one set of mediator i.e. strategic technology partnering capabilities were studied (Kilubi and Rogers, 2018), which means more research is necessary to explore the moderators and mediators between SCRES and firm performance.

4.1.3 Performance effect of supply chain restoration

Regarding the performance impact of SC restoration, only operational performance (e.g., quality, dependability, efficiency, responsiveness, customer satisfaction, delivery speed) is measured but no work on financial performance was observed. Three moderators, i.e., supply base complexity (Brandon-Jones et al., 2014), relational practice and network complexity (Chowdhury et al., 2019), and only one mediator, i.e., SC responsiveness (Yu et al., 2019), are found in the relationship between SC restoration and firm performance. This suggests that more research is necessary to clarify the impact of SCRES on firm and SC performances, including the direct and mediating effects and new moderators.

Table 3 Reasons and examples of citations between main clusters with original texts

Reason of the citation		*Example*	
		Citation	*Original texts from the citation*
1	Management of SC disruptions	Qrunfleh and Tarafdar (2013) (SC agility)	Table 1 Lean SCM practices Supplier selection, evaluating and monitoring (e.g., Qrunfleh and Tarafdar, 2013)
		Ruiz-Benitez et al. (2017) (SC restoration)	Suppliers and company involvement in NPD (New Product Development) (e.g., Qrunfleh and Tarafdar, 2013) Communication and information exchange between suppliers and company (e.g., Qrunfleh and Tarafdar, 2013).
		Braunscheidel and Suresh (2009) (SCRM) Blackhurst et al. (2011) (SC restoration)	Other scholars recognise the large amount of work that remains to be done in regard to supply chain disruptions and specific strategies to help firms increase the resiliency within their supply networks (e.g., Braunscheidel and Suresh, 2009).
2	Managerial decisions	Wagner and Bode (2008) (SC restoration) Kilubi and Rogers (2018) (SCRM)	Companies are obliged to manage their supply chains in an efficient manner to improve their flexibility and responsiveness (e.g., Wagner and Bode, 2008).
		Ritchie and Brindley (2007) (SCRM) Wagner and Neshat (2012) (SC restoration)	Researchers have taken on the challenge to support managers and public policy makers by providing knowledge about sources of supply chain risk, perceptions of supply chain risk, performance implications of supply chain risk (e.g., Ritchie and Brindley, 2007), and risk management and mitigation strategies.
3	Constructs and measures	Braunscheidel and Suresh (2009) (SCRM) Tse et al (2016) (SC agility)	According to Braunscheidel and Suresh (2009), SC agility can be measured as a second-order construct constituted by three common first-order constructs: demand response, customer responsiveness and joint planning.

Table 3 Reasons and examples of citations between main clusters with original texts (continued)

Reason of the citation		*Example*	
		Citation	*Original texts from the citation*
3	Constructs and measures	Braunscheidel and Suresh (2009) (SCRM)	<measures> Table A1 survey instrument Our firm empowers employees for individual learning to manage customer contact services effectively (Braunscheidel and Suresh, 2009).
		Shi et al. (2015) (SC Agility)	Our firm has been responsive to external market requirements and environmental regulations (Braunscheidel and Suresh, 2009).
4	Chain reaction	Thun and Hoenig (2011) (SCRM)	Supplier insolvency has the highest impact on the focal firm among all supply chain risks (Thun and Hoenig, 2011).
		Grotsch et al. (2013) (SC restoration)	If a culmination in the form of supplier insolvency occurs, firms run the risk of losing the supplier and, if so, a certain component essential for the production process (Thun and Hoenig, 2011).
		Blome and Schoenherr (2011) (SCRM) Blome et al. (2013) (SC agility)	As an illustrative example serves the automotive industry, which has been suffering from decreased customer demand due to the financial crisis… (Blome and Schoenherr, 2011).
5	Operational conditions	Wagner and Bode (2008) (SC restoration) Liu et al. (2014) (SCRM)	Modern supply chains are more vulnerable than ever (Wagner and Bode, 2008), because companies are now exposed to many types of risks.
		Wagner and Bode (2008) (SC restoration)	At the same time, global organisations face an increasingly unstable environment in many of their markets (e.g., Wagner and Bode, 2008) Kem et al. (2012) (SCRM)
6	Consequences of SCRES (Performance)	Blome et al. (2014) (SC agility) Kilubi and Rogers (2018) (SCRM)	In previous studies, supply chain performance has been measured by considering market-oriented factors such as flexibility and responsiveness (e.g., Blome et al., 2014).
		Zhao et al. (2013) (SCRM) Tse et al. (2016) (SC agility)	In the literature, there has been support of the direct effect of SC integration on firm performance (e.g., Zhao et al., 2013).

4.1.4 Performance effect in scattered clusters

As shown in Figure 4, similar to SC restoration cluster, only moderators (i.e., alliance/entrepreneurial orientation, SC complexity and supply uncertainty) but no

mediator is found in scattered clusters articles, further validating the need of future research on operational conditions and mediators that affect the relationship between SCRES and firm performance. Among the 14 articles in scattered clusters, only two articles (i.e., Kovach et al., 2015; Sahin and Topal, 2019) observes firm's financial performance, and more studies focus on operational performance (e.g., innovation, transparency, security), which is similar to the cluster of SCRM, which shows the urgent need of SCRES's financial performance impact in the literature.

4.2 Linkages between research areas and future research agenda

We found some common strategies when we compared the clusters of the research areas in Figure 4, which include visibility, integration, flexibility, information sharing and collaboration. This means that the different research areas could have mutually borrowed, modified, extended or advanced similar theoretical concepts, see Figure 3(b). We therefore performed an analysis to determine the reason behind the common attributes across the different research area, how they are linked to each other, and the possibility of integrating the different strategies of SCRES into a unified framework. Table 3 shows the reasons and examples of the citations between main clusters. In line with the performance impact of the clusters, we propose future research directions for the enhancement of the linkages and make the literature less fragmented in the perspective of CAS.

A CAS refers to an interconnected system of entities/agents exhibiting adaptive practices for dealing with the changes in the environment and the system itself (Choi et al., 2001). Day (2014) and Choi et al. (2001) outlined four common characteristics of a CAS.

1 CAS agents may share interpretive and behavioral rules (norms) and fitness criteria at different levels and scales (Choi et al., 2001). They adapt to disruption as they have the ability for dynamic learning. An agent can be an individual, a team, an organisation, or a business division. The agent observes system performance, obtains information from its surrounding environment, and information on the relationships among other entities. The newly obtained information is then incorporated into a decision-making process, which can affect the CAS system and other characteristics of the CAS. As a result, the agent evolves over time.

2 Co-evolution between agents takes place for sharing resources, information and financial sources across the entities in the system (Day, 2014). The co-evolution helps to determine how an event that took place, or a practice adopted by one entity affects the other entities.

3 The environment is the contextual condition that affects system performance. The relevant entities make changes to their activities to adapt to the environment and co-evolve by forming a new structure or adopting new practices through a better understanding of the dynamics and landscape which afford different levels of autonomy to specific partners (Choi et al., 2001).

4 Performance in the CAS theory is suggested to originate from the interactions among the agents of a system and is influenced by the surrounding environment. As the agents and their activities, subsystems, and environmental components evolve over time, performance impact becomes nondeterministic and nonlinear (Choi et al., 2001). The activities of agents at the micro level will not always significantly

influence the overall performance, while the actions at the macro level can have little effect on system performance (Choi et al., 2001).

A common area of the reviewed studies is the existence of complexity and the need for inter-dependent SC partners to dynamically adapt, change or respond to changing environments with the implementation of SCRES strategies (Ponomarov and Holcomb, 2009). The interconnective SC network and the adaptive ability to the external environment ensure firms to achieve better performance outcomes (Choi et al., 2001). Thus, we adopted the CAS theory to serve as the theoretical ground to explain the impact of SCRES on firm performance. Based on the CAS theory, this study provides a detailed map on the following four common characteristics of CAS to help explain the linkages between research areas and the performance impact of SCRES.

4.2.1 Agents and schema

CAS agents represent the SC partners in the field of SCRES. An agent makes decisions on the SC strategies and SCRES practices that it can adopt to manage SC disruptions by taking into consideration its SC partners, performance, environmental conditions, etc. Specifically, the direction of future research on SCRES is recommended as follows.

4.2.1.1 Strategies/practices

Management of SC disruptions is the first reason of linkages between main clusters in Table 3. For example, the strategies of mitigating risk, being flexible, having agility and being prepared which are proposed in Braunscheidel and Suresh (2009) (SCRM) are cited in Chan et al. (2017) and Yu et al. (2018) (SC agility). Swafford et al. (2006) (SC agility) is cited in Braunscheidel and Suresh (2009) and Wieland and Wallenburg (2013) which focus on SCRM, as examples of the strategies of SCRES (i.e., flexibility, adaptability) and their sources (i.e., co-location) in mitigating the negative effects of SC disruptions. This suggests the possibility of examining the combined and complementary effects between different SCRES strategies to see how they result in different performance outcomes.

Alternate SC strategies to achieve resilience are worthy of further investigation to identify effective approaches that reduce or even avoid disruptions and provide a quick response. Different SC strategies represent the different views of decision makers and affect organisational learning because they create boundaries and contexts which the decision-making process has to take into consideration and interpret (Fiol and Lyles, 1985). For example, future studies may want to investigate how different inventory strategies are used as an approach to maintain SCRES so that inventory costs are not affected, consider the development of visibility as a way to cope with unexpected disruptions. They may also want to consider the impact of different organisational measures (e.g., sales expenditures and staffing) or financial processes (e.g., debt structuring and leveraging) as well as other risk mitigating methods as approaches for SC agility (Kovach et al., 2015). These future studies will then provide firms with further guidance on their SC strategies which are crucial for facilitating SCRES.

4.2.1.2 Managerial decisions

As shown in Table 3, managerial decisions on the adoption of the strategies based on various business conditions is the second reason for the linkages between clusters. For example, Kilubi and Rogers (2018) (SCRM) cites Wagner and Bode (2008) and Ambulkar et al. (2015) (SC restoration) to emphasise the importance of decision making of firms to maintain SC's continuity in the face of disruptions. Wagner and Neshat (2012) (SC restoration) cites Ritchie and Brindley (2007) (SCRM) to highlight the role of sufficient information when managers make decisions on how to handle disruptions.

Future studies may wish to investigate the characteristics of decision-making agents (e.g., SC managers, CEOs, etc.) in firms which might affect their decisions in the face of disruptions. Brandon-Jones et al. (2015) examined the disruption and performance impact of managerial decisions on supply base complexity. Following Brandon-Jones et al. (2015), the research direction is then proposed to call for further studies on decision making characteristics. Organisational learning allows the compilation of new information so that decision makers can integrate the new information with existing wisdom, which then generates new knowledge (Slater and Narver, 1995). As SC complexity influences the decisions of managers, Brandon-Jones et al. (2015) laid the theoretical grounds that define the attributes of managerial decision making in the face of SC disruptions. Decision makers need to familiarise themselves with disruption situations and make appropriate decisions. It is often challenging to make such decisions and they need to be fluid due to the uncertainty of the duration of the disruption, location and severity. For example, the willingness of decision makers to take certain precautions might be affected by risk perception and attitude, which might affect decisions about how to cope with disruptions. Future research could compare the attitude of decision makers in the adoption of SCRES strategies before and after a disruption, and the changes in their decisions (e.g., amount of investment, and willingness to take action) over time. Future works could also examine the decision-making processes related to facing disruptions with realised or anticipated disruptions. The process of decision-making of an individual vs. that of a group might also be examined in terms of their effectiveness in coping with disruptions.

4.2.1.3 Constructs and measures

It requires constructs and measures of SC risk/disruption and SCRES to enhance the linkages between different clusters, see the third reason in Table 3. Wagner and Bode (2008) from the SC restoration cluster explored the sources of disruptions from demand and supply sides, regulatory/legal/bureaucratic, infrastructure and catastrophic sides, which are referred to the articles in the SCRM cluster (e.g., Kern et al., 2012; Lavastre et al., 2014). Braunscheidel and Suresh (2009) from the SCRM cluster is cited by articles in other clusters due to its measures of visibility (Brandon-Jones et al., 2014), agility (Chan et al., 2017; Tse et al., 2016), demand responsiveness and joint planning (Cantor et al., 2014).

Development of new theoretical constructs and validation of measurements of SCRES are important future research topics. Measures of firm resilience have been developed by Ambulkar et al. (2015), but they are difficult to apply, which calls for the need of further work. Previous studies have identified several practices that contribute to SCRES. The practices are summarised and classified into those that are upstream, focal,

or downstream based on how they are carried out (Christopher and Peck, 2004; Yang et al., 2021). Yet, most of the practices (e.g., lead time reduction, flexible transportation, demand-based management, etc.) lack clear guidelines that can be provided to managers for their development and implementation in the firms. It is therefore important to systematically conceptualise SCRES and provide specific SCRES practices for managers who can then maximise their resources towards specific organisational practices to manage SC disruptions within the relevant organisational operations and functions. The measurement scales and practices of SCRES could provide a useful reference for firms to use to evaluate their efforts on SCRES and identify areas of improvement.

4.2.2 Co-evolution (Interactions, chain reaction)

In SC networks, firms are required to adjust their activities over time as network changes can be affected by the dynamic impacts of the suppliers, customers and competitors. Radical structural changes could occur, thus leading to system-wide redefinition and reconfiguration of the SC to address disruptions (Choi et al., 2001).

It requires the diffusion of disruptions from one firm to its SC partners and the performance impact on related firms to link two clusters, see the fourth reason in Table 3. For example, Grotsch et al. (2013) (SC restoration) cites Thun and Hoenig (2011) (SCRM) to highlight the impact of disruptions caused by supplier insolvency (i.e. upstream partners). Blome et al. (2013) (SCRM) cites Blome and Schoenherr (2011) (SC agility) to call attention to demand uncertainties from customers (i.e. downstream partners).

In research on SCRES, the chain reaction of the partner firms in an SC when disruption occurs is an important topic for future studies. SCRES requires a certain amount of connectivity among the different SC partners (Ponomarov and Holcomb, 2009). The CAS theory indicates that the entire SC could be affected when one or more members of an SC are faced with disruptions (Hendricks et al., 2009). For example, an explosion took place at a steel supplier for Toyota (an automotive manufacturer) in February 2016, which led to a week-long halt of the production of more than 80,000 vehicles. Future studies may wish to investigate how a disruption that takes place in a firm would affect its suppliers and customers, and how SCRES strategies can be adopted to address the disruption. The research work would shed light on partnerships among SC partners and help to explain the impact of disruptions on the interrelationships in an SC.

4.2.3 Environment (operational conditions)

It requires similar environmental situations that a firm or an SC need to address, e.g., disruption and the demand for resiliency or robustness, to make two clusters closer, see the fifth reason in Table 3. For example, Wagner and Bode (2008) which is an SC restoration article is cited by Kern et al. (2012), Kilubi and Rogers (2018), Liu et al. (2014) and Macdonald and Corsi (2013), which are SCRM articles, as all realise the vulnerable and unstable environment firms often face in their SCs. This suggests the importance of taking account of operating conditions in future studies.

Future studies may extend the research in the area to investigate new operating conditions that affect the success of SC strategies in contributing to SCRES. To cope with the ever-changing business environment, SC strategies need to fit the operating conditions to build SCRES while achieving the SC objectives (Qi et al., 2009). This

research direction is proposed in light of the work by Qi et al. (2009) and Thome et al. (2014) in SC agility. For example, the influence of product characteristics, resource allocation, and cultural settings on SCRES may be examined in future studies. In addition, how different types of disruptions (e.g., environmental and legal issues, government disciplinary action) affect collaborative relationships amongst partners in SCs is an important research topic for gaining a better understanding on the role of collaborative relationships in SCRES.

In Figure 4, it is evident that the moderators who affect the impact of SCRES and firm performance are currently under explored. The impact of SCRES on firm performance can be moderated by the contextual conditions of firms, thus leading the path of SCRM to this research direction. The results of applying the CAS theory show that the consequences of learning depend on various contextual factors, e.g., strategies and environment. Li et al. (2015) pointed out the importance of exploring moderators in the relationship between SCRES and firm performance. Moderators serve as contingent factors to further understand the phenomenon of SCRES. These moderators may be the globalisation of SCs, SC integration, to environmental uncertainty and complexity, as they are found to have a crucial role in risk management in SC operations. Countermeasures for addressing environmental uncertainties and complexities such as new supply base structures, modular designs and local autonomy could be explored.

4.2.4 Performance (consequences)

It requires the wider consequences of strategies that are used to manage SC disruptions to enlarge common area of two different clusters, see the sixth reason in Table 3. For example, Tse et al. (2016) (SC agility) cites Zhao et al. (2013) (SCRM), and Shin et al. (2015) (SC agility) cites Braunscheidel and Suresh (2009) (SCRM), to provide evidence for hypothesis development on the performance impact of SCRES. Blome et al. (2013) and Tse et al. (2016) from SC agility cluster cite Braunscheidel and Suresh (2009) from SCRM cluster to make comparisons between newly obtained results and results from previous studies.

The literature still lacks a concordant understanding on the performance impact of SCRES, especially its impact on financial performance (see Figure 4). Taking the cluster of SC agility as an example, Chan et al. (2017) and Al-Shboul (2017) found that there is a significant relationship between SCRES and firm performance, while Gligor et al. (2015) and Shin et al. (2015) found the opposite to be true. The inconsistent performance impact of SCRES can be plausibly explained by different nature of SCRES strategies and their timing of adoption. Future research can explore what strategies of SCRES can be adopted and when they should be implemented for better performance outcomes. Longitudinal studies are also suggested for insights into how firms might establish SCRES as a process of SC reengineering and, most importantly, its performance impact over time. As the development of SCRES can be costly, future research need to investigate the trade-off between cost and impact of disruptions to improve performance (Qi et al., 2011). Examination of firm performance and that of a firm's partners would be valuable and have theoretical and managerial implications.

In addition, little is known about the mediators that affect the relationship between SCRES and firm performance. Mediators could explain SCRES-firm performance, especially its indirect correlations (Lavastre et al., 2014; Li et al., 2015). As shown in Figure 4, six mediators (i.e., customer effectiveness, cost efficiency, SC/operational

responsiveness, strategic supplier partnerships, postponement, and partnering/relational capabilities) have been examined in previous studies. Figure 4 shows the demand or market uncertainties, and changing inclinations, trends, preferences or expectations of customers which are important drivers that compel firms to adopt adaptive activities that show SCRES in response to changes in both the SC itself and the environment (Choi et al., 2001; Ponomarov and Holcomb, 2009). Customer orientation is considered to be a crucial factor for firms and a potential factor that can be used to improve performance. Customer satisfaction and loyalty and organisation reputation are indicators of customer orientation, while corporate social responsibility contributes to customer orientation. Future research can examine the mediating role of other factors such as customer and customer loyalty, corporate social responsibility and organisation reputation.

5 Discussion and conclusions

We applied an objective method to review the SCRES literature. Objectivity is the prime criterion used to ensure that the review is reliable and valid. We search, select, and review the existing literature through a SLR method. As a result, this study has selected and systematically reviewed 135 articles that focus on SCRES and their impact on firm performance. The CNA is conducted strictly based on citations, such that distinct research areas are classified based on the citations across one another by applying a GN algorithm (Girvan and Newman, 2002; Newman and Girvan, 2004).

We examined the citation networks and identified three major research areas, namely SC agility, SCRM, and SC restoration, which are seemingly fragmented. Based on the clustering result, we built a structured framework through conducting a comprehensive literature review that consolidates the study findings of the literature. We summarised the performance effects of SCRES through extracting factors related to the relationship from the articles in each cluster, which helps to identify theoretical and empirical gaps in the extant literature.

Different research areas of SCRES may have the same strategies in handling SC disruptions. They can be borrowed and extended by one another. Managers are suggested to adopt the kind of strategies such as knowledge management (Cantor et al., 2014), flexibility (Yu et al., 2018), visibility and information sharing with SC partners (Riley et al., 2016) that improve different qualities of firms simultaneously. Based on the CAS theory, we further found common grounds and observed the linkages across the research areas by identifying their mutual citations. Similar theoretical concepts can be borrowed, extended or advanced via citations among different clusters. Through analysing the formulation of the linkages among clusters, we proposed several research directions to strengthen connections across different research areas and integrate different SCRES strategies into a unified framework. The research directions are finally grounded in the CAS theory as a unified theoretical model for the performance impact of SCRES, standing for the underdeveloped research areas that future studies may pursue.

Managerial decisions are made by managers based on the disruptions happened in the firm or from supply chain partners (chain reaction and diffusion of disruptions) and other information (e.g., customer satisfaction, environmental conditions, firm performance). It is uncertain for the daily operations of the focal firm when a downstream or upstream partner is suffering from disruptions (Hendricks et al., 2009). To reduce the effect, we suggest managers to adopt SCRES strategies such as SC integration and collaboration

across functions and partner firms, geographic dispersion of the procurement from reliable suppliers to ensure supply stability, and outsourcing strategies from many other available suppliers in case of disruptions in existing supply (Liu and Lee, 2018; Liu et al., 2014; Lorentz et al., 2012).

This study has several limitations. First, we searched for articles that focus on the impact of SCRES on firm's business performance (i.e., operational or financial performance). Other performances (e.g., severity of disruptions) could be included in future research. Second, we only considered the 25 peer-reviewed journals. Future studies can select more journals or try not to limit journals in the article selection procedure. Third, we adopted a GN algorithm to classify the citation network. Future studies can use other algorithms, such as the Kernighan-Lin (KL) algorithm and Guimera-Amaral (GA) algorithm, to see whether different clustering methods can get equally satisfactory research areas for citation networks.

Acknowledgements

The authors thank the Editor and the reviewers for their constructive and insightful suggestions provided to improve the earlier version of this paper. This research is supported in part by the Hong Kong Polytechnic University (Account No. ZZGM). The authors would also like to thank for the Higher Education Fund of the Macao SAR Government (Grant No. HSS-MUST-2021-10) and the Faculty Research Grant of Macau University of Science and Technology (Grant No. FRG-22-015-MSB).

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