Where is Supply Chain Resilience Research Heading? A Systematic and Co-occurrence Analysis

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Abstract

Purpose – This paper algorithmically and objectively investigates the previous literature on supply chain resilience and advances theory by synthesizing new research domains.

Methodology – A two-staged analysis approach, integrating systematic literature review with VOSviewer co-occurrence analysis, was applied to the articles published between 2003 and 2018.

Findings –We find exponential growth in the literature on supply chain resilience over the last decade; however, there is still a gap for empirical research on numerous drivers, barriers, theories, moderators, mediators, and research methods intertwined in building supply chain resilience.

Research implications – The review identifies major clusters in which supply chain resilience research is conducted and devises a future research agenda based on the findings of co-occurrence analysis.

Practical implications – The findings provide managers with a broad spectrum of factors that are indispensable to build resilience and inform business policy.

Originality/value – While some systematic literature reviews exist in the current literature of supply chain resilience, we undertake a unique analytical perspective, resulting in an idiosyncratic set of research domains for further investigation in the area.

Keywords: Supply chain resilience, Literature review, Barrier, Driver, Moderator, Mediator, Research gaps, VOSviewer.

Paper type: Literature review

Introduction

Research on supply chain resilience (SCR) has enjoyed spectacular growth over recent years. The concept of SCR now represents a vibrant research area in supply chain management research (Ponomarov and Holcomb, 2009; Tukamuhabwa et al., 2015). The increasing interest in SCR is driven by globalization, technological changes and increasing focus on efficiency with a turbulent business environment, exposing businesses to a range of internal and external supply chain (SC) risks and disruptions (Ali et al., 2017). Overall, we think it is reasonable to argue that SCR has firmly established itself as one of the major research domains in contemporary supply chain management (SCM) scholarship.

Within the context of SCM, the concept of resilience emerged in 2003 (Rice and Caniato, 2003). Christopher and Peck (2004, p.2) were the first in providing a structured definition of SCR as 'the capacity of a system [supply chain] to return to its original state or move to a new, more desirable state after being disturbed.' This definition served as a foundation for more than decade-long research on the definition and implication of SCR (Kamalahmadi and Parast, 2016). Over the past decade, there has been notable growth in systematic literature reviews (SLRs) (Bhamra et al., 2011; Tukamuhabwa et al., 2015; Hohenstein et al., 2015; Ivanov et al., 2017; Datta, 2017; Kochan and Nowicki, 2018).

However, most of the existing SLRs are based on traditional descriptive, subjective, and content analysis approaches classifying research contribution on pre-defined (e.g., researcher's perception) coding or keywords schemes. They also cover only the early years of SCR research and have not been able to fully unify fragmented research on and understanding of SCR. Consequently, these reviews are unable to assess the degree to which repeated criticisms on the lack of unifying understanding of the SCR concept have been effectively tackled by more recent research, and to what extent these latest examinations have broadened the nomological network in which SCR is embedded.

In this study, we intend to fill this research gap by pursuing two interrelated objectives. First, to objectively capture a broader landscape of recent trends and evolutionary trajectories in SCR literature, we undertake a unique analytical approach that combines SLR (Denyer and Tranfield, 2009) with VOSviewer Co-occurrence Analysis (VCA) (van Eck and Waltman, 2009). For VCA, we use a freely available VOSviewer software package (www.vosviewer.com). While SLR enables to retrieve the relevant articles in the area, VCA helps to objectively and algorithmically identify and aggregate the key terms into distinct clusters, representing the main research domains and directions of the future research in the field. This novel review culminates in repertoire drivers and barriers to building SCR, intervening mediators/moderators, theoretical underpinnings, and methodological perspectives.

Second, we aim to go beyond existing knowledge on SCR to pinpoint significant research gaps in the literature, unanswered issues, and promising directions to provide foresight into the future of SCR research. We use findings from SLR and VCA as a springboard for our evaluation and particular suggestions for further research on SCR. Formulating clearly defined, informative, and answerable research questions (RQs) is the first step to a SLR (Denyer and Tranfield, 2009). As such, this review builds upon two specific RQs:

RQ1. What is the state-of-the-art in the existing supply chain resilience literature?

RQ2. What are the potential domains of SCR research and opportunities for further research?

The rest of the paper is structured as follows. Section 2 explicates the conceptual background of SCR. Section 3 outlines the literature review methodology. Section 4 presents result and discussion, including descriptive statistics, key research domains, and trends in the literature. Future research directions and conclusions, including theoretical and managerial implications, have been provided in Section 5.

Conceptual background

Given the plethora of research on SCR drawing on different approaches and producing fragmented insights (Bhamra et al., 2011; Tukamuhabwa et al., 2015; Hohenstein et al., 2015; Ivanov et al., 2017; Datta, 2017; Kochan and Nowicki, 2018), SCR concept lacks a unified understanding. For example, while some studies concentrate on disruption recovery as SCR (Ivanov et al., 2017), others label it as supply network resilience (Datta, 2017). Therefore, we summarize the conceptual background of SCR that helps to clarify the scope of this article ahead of delving into a systematic analysis of the SCR research.

Globalization, shorter product life cycles, and turbulent socio-political environments make SCs vulnerable to potential disruptions and adversities (Hohenstein et al., 2015). Political upheavals, work accidents, natural disasters, financial crises, and supplier failures can affect both the revenues and costs of the entire SC (Craighead et al., 2007). Given these contemporary environmental diagnoses, SCs' capacity to provide an efficient an effective response to potential disruptions and recover to their original state or even better in the aftermath of disruptive events is called SCR (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009).

Since its initial applications to examine related SCM phenomena (Christopher and Peck, 2004), SCR research has quickly formed its own unique identity and grown to build a distinct body of research in the field. In particular, though some scholars have earlier viewed SCR as a component of SC risk management (Kamalahmadi and Parast, 2016), a substantial body of research in SCM view it as a phenomenon of its own. Accordingly, SCM research has developed independent definitions of SCR, one of the seminal ones is,

> *the adaptive capability of an SC to prepare for unexecuted 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* (Ponomarov and Holcomb 2009, p.131).

The distinct features of SCR is that 1) it can be built into a system in advance of a disruption, 2) sophisticated and extensive inter-organizational collaboration is necessary to identify and cope with risks, 3) reacting quickly to unforeseen events is of fundamental importance, and 4) the overarching culture of risk management is a necessity to develop SCR (Christopher and Peck, 2004). Its broad set of applications, together with the intrinsic salience of the issue, has made SCR of interest to a wide range of scholars in SCM and beyond. However, research on SCR has also been facing growing criticism over the true value and applicability of SCR as well as the lack of unifying theme behind SCR research (Kamalahmadi and Parast, 2016). Thus, we next turn to a two-staged systematic analysis of recent research on SCR.

Literature review methodology

Consistent with the research questions, our review methodology combines and employs the two approaches in the two consecutive stages. In stage 1, we undertake an SLR approach to search, evaluate, and select the most relevant research articles in a reliable way (Denyer and Tranfield 2009). In Stage 2, we apply VCA to algorithmically and objectively analyze selected articles (van Eck and Waltman, 2009) and recognize emerging research domains. Combination of the two approaches (Figure 1) is aimed to enhance the analytical rigor and achieve more reliable findings.

Insert Figure 1 about here

Drawing upon Stage 1 (SLR), the articles were searched starting from the first publication on SCR appeared in 2003 (Rice and Caniato, 2003) to the articles published till December 2018. Scopus and Web of Science (WoS) are the two widely used large databases that are compatible with VOSviewer software. We separately ran the search on both databases and found that Scopus' coverage is more extensive than WoS, thereby selected Scopus to retrieve the articles

for this review. Aiming at the articles that draw upon or contribute to the theories in the operations and SCM field, in line with Kamalahmadi and Parast (2016), we focused on the three main domains of management discipline: operations management, operations research and business management/reviews. The articles were searched by applying multiple keywords related to SCR including "supply chain resilience*", OR "supply chain uncertainty", OR "supply chain vulnerability", OR "supply chain disruption" OR "robust supply chain". A double quotation mark was applied to each term in order to collect more relevant articles.

Further, an asterisk (*) sign was placed on the term 'resilience' minimizing the risk of losing the articles using the word 'resiliency' or 'resilient'. The iterative search process yielded 189 articles. Selection of peer-reviewed journals warrants that a literature review maintains a certain level of quality and reliability (Tang and Nurmaya Musa, 2011). As such, we omitted conference papers, magazines, and master/doctoral dissertations. As a result, 34 articles were eliminated, leaving 155 articles published across 20 international peer-reviewed journals.

In stage 2, VCA was performed using VOSviewer clustering functions (1-3), which help compute similarities between key terms given their association strength and a weighted sum of squared distance:

$$As_{ij} = \frac{C_{ij}}{c_i c_j} \qquad (1)$$

Wherein cij is the number of co-occurrences of items i and j, ci is the total number of co-occurrences of item i, and cj the total number of co-occurrences of item j.

$$\frac{2}{n(n-1)} \sum_{i<j} ||X_{i\_}X_j|| = 1 \qquad (2)$$

Where n means the number of nodes in the network, X_i indicates the location of the node i in a two-dimensional space, and $X_{i\_}X_j$ denote the Euclidean distance.

Next, the software helps cluster together similar key terms employing the following mathematical function:

$$Q(d_{1,..},d_n) = \sum_{i<j} \delta(d_i, d_j)(s_{ij} - \gamma) \qquad (3)$$

Where, n denotes the number of publications, s_{ij} denotes the relatedness of publication i with publication j, γ shows a resolution parameter, d_i denotes the cluster to which publication i is assigned. The function δ (d_i, d_j) equals 1 if $d_i=d_j$ and *0* otherwise. The three functions (1-3) have the ability to allocate each publication to only one cluster (domain), reducing the risk of publications' overlapping to different clusters.

Descriptive statistics

Before the VCA analysis, descriptive statistics were used to capture some major trends in the extant literature, encompassing the year-wise and journal-wise distribution of articles in the field of SCR.

The year-wise distribution of articles indicates (Figure 2) an uneven trend in the number of publications from 2003 to 2015. However, significant growth in articles is evident over the past three-year—2016 to 2018. Distributing the time of articles into two halves explicates that the share of the articles in the second half (2011-2018) is about four times (124 articles) greater than the first half (31 articles). This growth of research in recent years proves the significance of SCR to firms' competitiveness and mounting interest of researchers on the topic.

Insert Figure 2 about here

In addition, the journal-wise distribution (Figure 2) depicts that more than half of the articles (82 of 155) were published in the five international peer-reviewed journals: *International Journal of Production Research (40); International Journal of Physical Distribution and Logistics Management (12); International of Production Economics (11); Supply chain Management: An International Journal (11); and Transportation: Part-E (8).*

The increasing number of articles in the international peer-reviewed journals indicates that SCR is an influential research agenda. These findings could also guide researchers towards appropriate outlets for their prospective publications.

Analysis and synthesis of findings

VCA analysis

Building upon the insights from the software's website (www.vosviewer.com), van Eck and Waltman (2009) and Qaiser et al. (2017), we performed VCA analysis of 155 articles, resulting into the six major clusters (Figure 3). Cluster 1 (red color) and Cluster 2 (green color) demonstrate SCR drivers and barriers as well as performance outcomes. Cluster 3 (blue color) ascertains underpinning theories. Cluster 4 (yellow color) represents moderators and mediators. Cluster 5 (purple color) uncovers research methodologies.

Insert Figure 3 about here

Further, given the VCA outcomes, we scanned through all 155 articles, recognizing the current research trends and main research domains in each cluster as discussed in the following sections.

Cluster 1 and 2: SCR drivers, barriers and consequences

Cluster 1 and 2 expound SCR drivers, barriers, and consequences. The SCR drivers, also called enablers, elements, or principles, are the resources and capabilities to cultivate SCR. Given the context of studies, the previous literature reviews have identified a variety of SCR drivers over time. For example, Pettit and Fiksel (2010) suggested 14 drivers of SCR, including flexibility, efficiency, visibility, adaptability, anticipation, recovery, dispersion, collaboration, security, and financial strength. Hohenstein et al. (2015) identified eight drivers (elements) to SCR, constituting collaboration, inventory management, pre-defined decision plan, redundancy, visibility, agility, and flexibility. Kamalahmadi and Parast (2016) retrieved ten drivers

(principles), embracing SC engineering, agility, SC risk management, visibility, velocity, information sharing, leadership, redundancy vs. flexibility, and contingency strategies. Recently, Kochan and Nowicki (2018) identified 16 drivers, involving agility-velocity, redundancy, efficiency, dispersion, organizational culture, anticipation, adaptability, and recovery.

Unlike the existing SLRs, which build upon subjective and content analysis approaches, we have algorithmically identified 22 drivers of SCR using VCA analysis. In doing so, our work both corroborates findings of previous SLRs and expand the literature by adding numerous new SCR drivers, such as Industry 4.0, blockchain technology, big data analytics, additive manufacturing, disruption mitigation, and staff training (Table I). Additionally, we ranked the SCR drivers based on their number of occurrences in various publications, facilitating readers in understanding of the relative importance and opportunities for further work. Given their time of action, purpose, and definition, we have grouped the 22 SCR drivers into three major classes: preparedness, resistance, and rebound (Table I).

Insert Table I about here

Preparedness. The preparedness related SCR drivers enable a firm to prepare for an unforeseen incident before its occurrence. The analysis of 155 articles revealed 13 SCR drivers pertaining to preparedness, wherein six drivers gained more attention with various empirical and conceptual contributions. These include: flexibility (59 studies e.g., Braunscheidel and Suresh, 2009; Sheffi and Rice, 2005; Yang and Hsu, 2018), SC collaboration (46 studies e.g., Scholten et al., 2014; Singh et al., 2018; Christopher and Peck, 2004), redundancy (30 studies e.g., Sheffi and Rice, 2005; Ivanov and Sokolov, 2013; Yang and Hsu, 2018), resilience culture (27 studies e.g., Christopher and Peck, 2004; Williams et al., 2009; Kwak et al., 2018), information sharing (25 studies e.g., Braunscheidel and Suresh, 2009; Dubey et al., 2018b; Urciuoli et al., 2014),

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and SC innovation (19 studies e.g., Fiksel et al., 2015; Treiblmaier, 2018; Reinmoeller and Van Baardwijk, 2005).

Of 13 drivers, the following four have received relatively little empirical research: Top management support (10 studies e.g., Gunasekaran et al., 2011; Ponomarov and Holcomb, 2009; Reinmoeller and Van Baardwijk, 2005), employees training and development (5 studies e.g., Ali et al., 2017; Bhattacharjya, 2018; Ruiz-Benitez et al., 2018), public-private partnership (6 studies e.g., Ali et al., 2017; Singh et al., 2018; Stewart et al., 2009), and co-opetition (3 studies, Bakshi and Kleindorfer, 2009; Richey, 2009; Wieland and Wallenburg, 2013).

The last three of 13 drivers recently appeared in the literature and need immediate attention for further investigation: big data analytics (3 studies, Dubey et al., 2018b; Ivanov et al., 2018; Papadopoulos et al., 2017), Industry 4.0 (3 studies, Ivanov et al., 2018; Ivanov et al., 2016; Strozzi et al., 2017), and blockchain technology (Ivanov et al., 2018).

Big data analytics (BDA) means gathering, managing and analyzing a large and complex data set to unveil hidden patterns that could cause turbulence (Dubey et al., 2018b; Strozzi et al., 2017). The findings of BDA could help safeguard a firm from adversities by simulating a variety of scenarios in advance.

Industry 4.0 or fourth industrial revolution refers to full automation through the Internet of Things (IoT), cyber-physical systems, cloud and cognitive computing where products are assembled without human interaction (Ivanov et al., 2018). Industry 4.0 elicits higher flexibility, collaboration, connectivity, real-time information sharing, cost reduction, and shorter lead time, allowing to reduce the need for structural SC redundancies and gain competitive advantage.

The blockchain is a digital ledger in which real-time transactions are recorded in an extensive network of globally connected computer systems (Ivanov et al., 2018). Application of blockchain in SC is becoming essential to enhance product traceability, visibility, real-time

coordination, and control product tampering, and counterfeiting. Blockchain could help prevent unforeseen incidents by creating risk profiles and mapping end-to-end SC.

Resistance. The second category of SCR drivers belongs to resistance—the ability to resist disruption and minimize the losses. In total, 141 studies from our sample (155) implied four drivers of resistance, comprising: agility, visibility, robustness, and velocity (Table I). Three of the four drivers are widely discussed in the extant literature with considerable empirical and theoretical work, including: visibility (49 studies e.g., Peck, 2005; Ivanov and Sokolov, 2013; Dubey et al. 2018b), robustness (43 studies e.g., Brandon-Jones et al., 2014; Gunessee et al., 2018), and agility (40 studies e.g., Blackhurst et al., 2005; Wieland and Wallenburg, 2013; Yang and Hsu, 2018). However, the last driver—velocity (9 studies e.g., Peck, 2005; Fiksel et al., 2015; Kwak et al., 2018)—has received scant attention in terms of the total number of studies and empirical validation, alike.

Rebound. The third category of SCR drivers is rebound—the ability of a firm to recover from the disruption and continue operations in a healthy or even better way. Overall, 119 studies from our sample enumerated five drivers to rebound. The first three drivers received plenteous empirical and theoretical research, including: adaptation (50 studies e.g., Ponomarov and Holcomb, 2009; Kamalahmadi and Parast, 2016; Machado et al., 2018), resource configuration (31 studies e.g., Braunscheidel and Suresh, 2009; Ambulkar et al., 2015; Liu and Lee, 2018), and disruption mitigation (28 studies e.g., Fiksel et al., 2015; Marley et al., 2014; Machado et al., 2018).

Comparatively, the last two drivers have gained little empirical research, constituting: SC redesign (9 studies e.g., Christopher and Peck, 2004; Christopher and Holweg, 2017; Machado et al., 2018) and additive manufacturing (Ivanov et al., 2018). Specifically, additive manufacturing is considered instrumental in recovering from natural disasters (Ivanov et al., 2018). However, there is a lack of empirical contributions on its effectiveness. Additive

manufacturing is a process of joining material layer upon layer from the 3D model or CAD using smart machines (Ivanov et al., 2018). Given the ability of machines to process multiple materials remotely, in the event of natural disasters, additive manufacturing could be used for on-site manufacturing of not only small items such as utensils, cups, buckets, medicines, but also complete 3D printed homes (www.apis-cor.com).

SCR barriers. Barriers of SCR is another essential research domain appeared in cluster 1 and 2. Barriers refer to the forces that negatively impact on resiliency (Blackhurst et al., 2011). Despite their criticality, the review of sampled articles revealed that only 4 (3%) studies discussed some barriers to building SCR (Table I), comprising: flow activities (port congestion, stringent regulations), flow units (product complexities), sources of flow units (volatility of supplier's location) (Blackhurst et al., 2011); resource scarcity, asset problems, and cash flow (Pal et al., 2014); lack of collaboration, visibility, the lack of trust and financial weakness (Roberta et al., 2014); and the lack of IT integration, R&D and autonomy of control (Ali et al., 2017). The first study is exploratory as opposing to theory testing. The second study suggests barriers to procurement activities only, thus lacking a holistic perspective. The third study was conducted in response to bankruptcy issues in the Swedish textile industry; thereby, findings are specific to the banking and finance sector. The fourth study is based on interviews with citrus industry managers in Australia, owing to geographical and sampling limitations. Given the existing research void, we call the researchers' attention for further research on the barriers that could impede a firm's capability to build SCR.

Consequences. The last research domain that emerged in cluster 1 and 2 is the consequence or performance outcome. Understanding of different consequences or performance outcomes is indispensable to investigate the results of investments in various SCR drivers, barriers, moderators, and mediators. Given this, our analysis presents a variety of consequences or performance outcomes, including: enhanced SCR (121 studies e.g., Dubey et al., 2018a; Ates

and Bititci, 2011; Christopher and Peck, 2004), improved operational performance (25 studies e.g., Stevens and Johnson, 2016; Truong Quang and Hara, 2017; Dabhilkar et al., 2016), competitive advantage (7 studies e.g., Ponomarov and Holcomb, 2009; Kwak et al., 2018; Gunasekaran et al., 2011), SC customer value (Wieland and Wallenburg, 2013), and service performance (Liu et al., 2017). Surprisingly, 78% of the studies considered enhanced SCR as a consequence/performance outcome, highlighting a substantial gap for research on operational performance, competitive advantage, customer value, and service performance.

Cluster 3: Theoretical underpinnings

Theoretical underpinnings of SCR research are displayed in cluster 3. A theory-based study can confirm or extend an existing theory, and build a new theory (Ketchen and Hult, 201; Dubey et al., 2015), adding additional knowledge to the literature. Among 155 articles, 61 applied 11 theories, constituting: resource-based view (23 studies e.g., Ponomarov and Holcomb, 2009; Ali et al., 2018; Yang and Hsu, 2018), relational view (7 studies e.g., Wieland and Wallenburg, 2013; Gabler et al., 2017; Mandal, 2017), dynamic capability (7 studies e.g., Golgeci and Ponomarov, 2013; Dabhilkar et al., 2016; Chowdhury and Quaddus, 2017), control theory (5 studies e.g., Ivanov and Sokolov, 2013; Ivanov et al., 2016; Dolgui et al., 2018), complexity theory (6 studies e.g., Day, 2014; Gunasekaran et al., 2015; Papadopoulos et al., 2017), contingency theory (3 studies e.g., Brandon-Jones et al., 2014; Ali et al., 2018), Treiblmaier, 2018), normal accident theory (3 studies e.g., Marley et al., 2014; Bode and Macdonald, 2017; Scheibe and Blackhurst, 2018), social capital theory (3 studies e.g., Stewart et al., 2009; Akgün and Keskin, 2014; Bhattacharjya, 2018), game theory (2 studies e.g., Bakshi and Kleindorfer, 2009; Zahiri et al., 2017), social exchange theory (Stevenson and Busby, 2015), and systems theory (Blackhurst et al., 2011).

Astoundingly, more than half of the studies (37) underpin three theories: resource-based view, relational view, and dynamic capability theory. Additionally, most of the studies

underpinned a single theoretical perspective. Nonetheless, a combination of more than one theory could explore their complementary characteristics (the missing traits) and better comprehend the multi-dimensional issues of SCR.

Cluster 4: Moderators and mediators

Moderators and mediators that are intertwined in building SCR were revealed in cluster 4. Moderator is a third variable that affects the strength of the relationship between independent and dependent variables. Of 155 articles, only 9 studies discussed some moderators (Table I), including: recovery warning (Craighead et al., 2007), flexibility and redundancy (Zsidisin and Wagner, 2010), environmental turbulence (Akgün and Keskin, 2014), geographical dispersion, scale complexity, differentiation, delivery complexity (Brandon-Jones et al., 2014), product complexity (Eckstein et al., 2015), consortium support, firm size, SC risks (Ali et al., 2017), technological orientation (Mandal, 2017), organizational culture (Altay et al., 2018), and top management commitment (Dubey et al., 2018a). Thus, despite the significant influence of moderators in building SCR, it is somewhat surprising that only 6% (9) of studies examined the possible moderators. A quick review of these articles further reveals that impact of some moderators (recovery warning, barriers, consortium support) had not been yet quantitatively tested, while others have been empirically tested considering large firms only.

Mediator refers to the mechanism through which an independent variable influences the dependent variable. The analysis of sampled articles revealed 7 studies suggesting some mediators, involving: innovation magnitude (Golgeci and Ponomarov, 2013), product innovativeness (Akgün and Keskin, 2014), visibility (Brandon-Jones et al., 2014), recognition, diagnosis, development, implementation (Bode and Macdonald, 2017), swift trust (Dubey et al., 2018b), agility, integration, SC engineering (Liu et al., 2017), and security management (Yang and Hsu, 2018). Thus, despite their critical role between SCR and firm performance, only 4.5 % (7) of studies in our sample investigated mediators.

Cluster 5: Methodological perspectives

Cluster 5 revealed four methodological perspectives from our sampled articles (Table I), including: conceptual (33 studies e.g., Rice and Caniato, 2003; Ponomarov and Holcomb, 2009; Ivanov et al., 2018), simulation/mathematical modeling (48 studies e.g, Datta et al., 2007; Cardoso et al., 2015; Beheshtian et al., 2018), qualitative case studies (39 studies e.g., Blackhurst et al., 2005; Gunasekaran et al., 2011; Scheibe and Blackhurst, 2018) and survey-based methods (35)—single-method (31 studies e.g., Braunscheidel and Suresh, 2009; Mandal, 2012; Zhang et al., 2018), and mixed-methods (4 studies e.g., Pettit et al., 2013; Treiblmaier, 2018; Ali et al., 2018).

Almost half of the studies (81) build upon conceptual frameworks and simulation/mathematical models, most of which lack the support of real-world data. One-fourth of the studies (39) adopted a qualitative case study. Survey-based research stands at the lowest level with only 35 studies (31 single quantitative method plus four mixed-methods) indicating gap for high-quality survey-based studies, particularly, mixed-methods research.

Opportunities for future research

Although recent insights strongly underline the value of the SCR and help give substance to significant elements of the phenomenon, further research is necessary to advance its fuller understanding. While putting forward recommendations for future research, we focused on issues that are derived from our systematic and co-occurrence analysis and that we believe would benefit from additional attention above and beyond what has already been accomplished in recent years.

In discussing future research directions, we follow the same themes (i.e., SCR drivers, barriers, moderators, mediators, theoretical underpinnings, and research methods) that are covered in the analysis and synthesis of findings section almost in the same order. In each

subsection, we put forth our assessment and our recommendations that draw on but go beyond those themes discovered in past research.

SCR drivers, barriers, and consequences

As our analysis reveals, there has been a great deal of research on the drivers of SCR through different angles. However, there is still a dearth of large-scale theory-based studies on many drivers and their performance outcomes. Specifically, we highlight the need for large-scale empirical research on big data analytics, blockchain, Industry 4.0 technologies, additive manufacturing, in addition to the co-opetition, velocity, resilience culture, top management support, SC collaboration, and innovation.

Additionally, there is a further room to explore what factors could hinder SCR, given the currently dominant focus on positive antecedents of SCR. The investigation of such negative factors could enhance the knowledge on SCR as it would explore overlooked issues in SCR that could offer a unique angle to the achievement and preservation of SCR.

Furthermore, limited broad empirical evidence exists as to whether SCR leads to increased performance outcomes. Thus, further research on the possible performance outcomes of SCR is warranted. Performance outcomes may not be the only prospective outcomes of SCR. There might be intermediate or more proximate/particular outcomes of SCR that bridge the gap between SCR and performance outcomes and concentrate on the more specific consequences of SCR. For example, SCR may shape firms' subsequent investment decisions and operating modes. Hence, we recommend reorienting the investigation of SCR outcomes to concentrate more on proximate outcomes across multiple levels, including individuals and firms.

Moderators and mediators

Given the complexity, dynamism, and disruptiveness of the global business environment (Akgün and Keskin, 2014; Machado et al., 2018), virtually no linkage between SCR and its

drivers and consequences would be universal or timeless. It is highly likely that the manifestations of SCR would be unique to the context in which they occur and may change over time. Accordingly, there is a pressing need to enrich the literature with research exploring the boundary conditions (i.e., moderators) of SCR as well as mediating mechanisms between the known SCR drivers and consequences. Likewise, longitudinal research that accounts for the role of temporal dynamics in the evolution and deployment of SCR would enrich the understanding of how firms respond to adverse change.

A possible direction on the boundary conditions of SCR would be an in-depth exploration of the role of firm characteristics. For example, small and medium enterprises (SMEs) face internal shortages of information, capital, management time, and experience, while externally, they face constraints arising from their vulnerability to environmental changes (Pal et al., 2014). As such, future research can explore how SMEs create resilience facing adversities, and whether SMEs size (small vs. medium) moderate the relationship between SCR and SMEs' performance.

Prospective research could also examine SCR in developed vs. developing countries, which would provide additional moderating factors such as institutional development and institutional voids, cultural factors, the degree of internationalization, political risks, entry modes, and geographic diversification to account for when exploring the boundary conditions of the linkage between SCR and its consequences. This would provide valuable insight into the literature, whether SCR research in developed countries can be applied in developing countries and how SCR is developed and manifested across national borders. Such an approach would also link SCR better with the extant research of global SCM and SC risk management.

Besides, SCR does not necessarily stem from mechanistic processes. It is based on unique sense-making and enactment of agents embedded in SCs, and thus, every experience of SCR could be unique to the involved SCM managers. Therefore, our findings on the mediating

mechanisms of SCR could also include behavioral variables that are germane to SCM managers. In this vein, the exploration of mechanisms (i.e., mediators) that explicate proposed relationships of SCR with other variables is an area of weakness in the current literature (cf. Gölgeci and Kuivalainen, 2019).

Theoretical underpinnings

Although the use of theory in SCM is growing, it is currently not at the desired level of application (Gligor et al., 2019). Researchers have so far primarily relied on a limited number of theories to help explain the phenomena of interest, and in most cases borrowed theory from other fields without due consideration and adaptation (Ketchen and Hult, 2011). As our findings reveal, SCR research has often suffered from the deficiency of theory. Thus, researchers ought to apply additional rigorous theories when examining multidimensional issues of SCR.

In particular, boundary-spanning theory, organizational inertia theory, prospect theory, and resource-advantage theory would be insightful lenses in addition to the existing theories such as resource-based view, relational view, dynamic capability view, control theory, complexity theory, and systems theory that are found to be currently popular among SCM researchers examining SCR. For example, while boundary-spanning theory can inform relational underpinning of SCR, prospect theory can be a useful toolbox to understand how SCM managers' risk perceptions influence SCR. Keeping on developing and illuminating relevant theoretical assumptions underlying SCR research can help clarify issues that remain unknown or issues with conflicting findings.

Future research should also examine how theories used in other fields can advance our understanding of SCR. For example, perceived risk processing theory, real options theory, and relational governance theory from marketing, and paradox theory, creativity theory, social interdependence theory, and learning theory from management, can offer unique angles. The

use of such theories can help challenge the rooted assumptions on the consequences of SCR that is witnessed in the mainstream SCM research on SCR and explore potential trade-offs and tensions involved in developing and deploying SCR. This is important to acknowledge because unlike some assumptions, SCR is not an immutable quality, and may involve some trade-offs that may result in unfavorable situations under certain conditions.

Likewise, beyond specific theoretical lenses, researchers can explore the interplay between SCR and other major domains in SCM research. For example, SC agility, sustainability, and SC relationships phenomena are gaining increasing importance, investigating potential synergies, or trade-offs between these phenomena and SCR can lead to fruitful research avenues.

Research methods

As the SCM field witnesses the significant advances in research methodologies over the recent years (Tsan-Ming et al., 2016), the exploration of SCR could benefit from a portfolio of research methodologies beyond the most extensively applied ones. The research needs new methods to inform the way scholars seek answers to issues related to SCR and boost the validity of research findings.

In their SLR, Tukamuhabwa et al. (2015) find that most previous studies on SCR were conceptual. Contrarily, our analysis establishes an increasing trend of empirical work over the past two years. This trend can be enhanced through the application of a variety of research methods. Beyond qualitative case and survey data analyses, scholars could consider employing relatively less applied methodologies, such as field studies and secondary research to widen further the toolkit used in SCR research.

Additionally, most of the existing studies applied a single research method, thus leaving a significant gap for mixed-methods and multi-methodical research. The mixed-methods approach provides a better understanding of problems through the triangulation of findings

while eliminating the weaknesses inherent in a single method. Similarly, a multi-methodological approach can help address complex and intriguing SCM issues of SCR, derive solid results, and boost the scientific merit of SCM research (Tsan-Ming et al., 2016). Mixed-methods and multi-methodical research can also overcome the generalizability, precision, and realism trade-offs involved in any single-research method (McGrath, 1981). Thus, the current scarcity of novel methodological approaches stresses the need for more mix-methods and multi-methodical research on the topic of SCR.

Finally, scholars can also explore the opportunities provided by lesser applied yet emerging research methods such as qualitative comparative analysis (QCA), experiments, and archival research. For example, experimental studies can enable much-improved measurement precision of the variables related to SCR and allow the causal analysis of the potential SCR drivers and consequences that could not be fully assured through cross-sectional studies (Deck and Smith, 2013). Archival research, using secondary data sources, can enable drawing longitudinal and historical picture of the evolution of SCR in a given firm or industry and allow accounting for factors that evolve.

Conclusion

Theoretical implications

The purpose of this study was to capture a broader landscape of recent trends and evolutionary trajectories in SCR literature and pinpoint significant research gaps in the literature, unanswered issues, and promising directions to provide foresight into the future of SCR research. We found exponential growth in the literature on SCR over the last decade across multiple domains and research issues, including drivers, barriers, theories, moderators, mediators, and research methods intertwined with SCR. Nonetheless, we also found and reflected upon the fact that there is still a significant gap for empirical research on various issues surrounding SCR phenomena.

In essence, research examining SCR phenomenon need to explore heretofore overlooked issues in explaining SCR such as big data analytics, blockchain, Industry 4.0, top management support, co-opetition, and SC collaboration as well as diverse consequences of SCR. Likewise, scholars need to broaden their theoretical and methodological toolkit to harness unique insights into SCR above and beyond what we know so far. For example, boundary-spanning theory, organizational inertia theory, prospect theory, resource-advantage theory, real options theory, and paradox theory can be insightful lenses that could be adopted via new methodologies such as QCA, experiments, and archival research to truly advance our understand of SCR.

Managerial implications

The findings enable firm-managers to understand the repertoire of drivers and barriers that are intertwined in building SCR. This knowledge is imperative to facilitate managers in making more informed investment decisions to building SCR. For example, our comprehensive analysis of various antecedents of SCR highlight that managers seeking to achieve SCR need to rely on a holistic set of factors that include various dimensions of preparedness, resistance, and rebound. We also attempt to broaden the managers perspective by providing insights into various performance outcomes as a result of investments in SCR factors. We argue that SCM managers that deploy SCR are more likely to witness their firm achieving improved operational performance, competitive advantage, SC customer value, and service performance.

Furthermore, our exploration of the moderators and mediators show that achieving SCR is not a mechanistic and straightforward process but depends on boundary conditions and underlying means. Through collating diverse mediators and moderators at one place, we urge firm-managers to consider numerous situational factors and mechanisms that act as a linking pin between SCR drivers/enablers and SCR outcomes.

Concluding remarks

Given the realities of the contemporary global business environment, it is pleasuring to note that SCR has gained its rightful place in SCM research. However, without a unifying research framework and theoretically grounded future research agenda, the advancement of SCR research can be stalled. In this research, we conduct systematic and co-occurrence analysis of the past research on SCR and develop a thorough research agenda grounded in the findings of our analysis. Consequently, we offer some angles to the question of where SCR research is heading, and we hope while our analysis can synthesize and advance the knowledge on SCR, our research agenda can spur further conversation on SCR.

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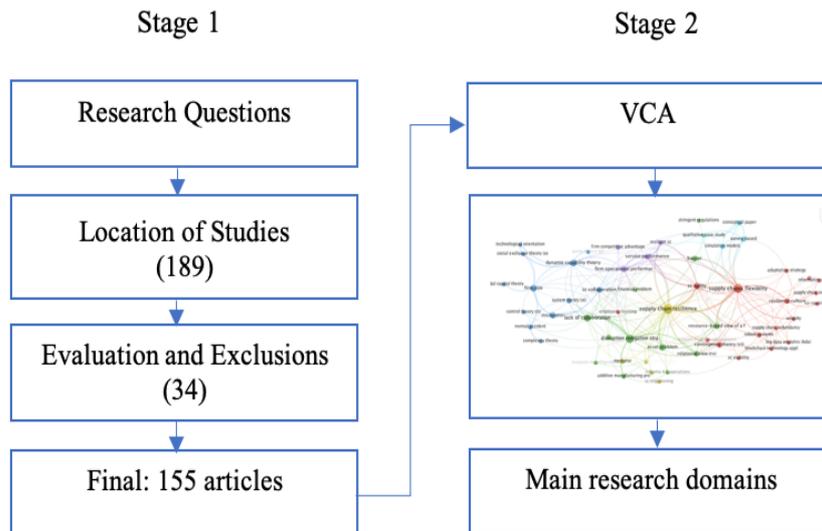
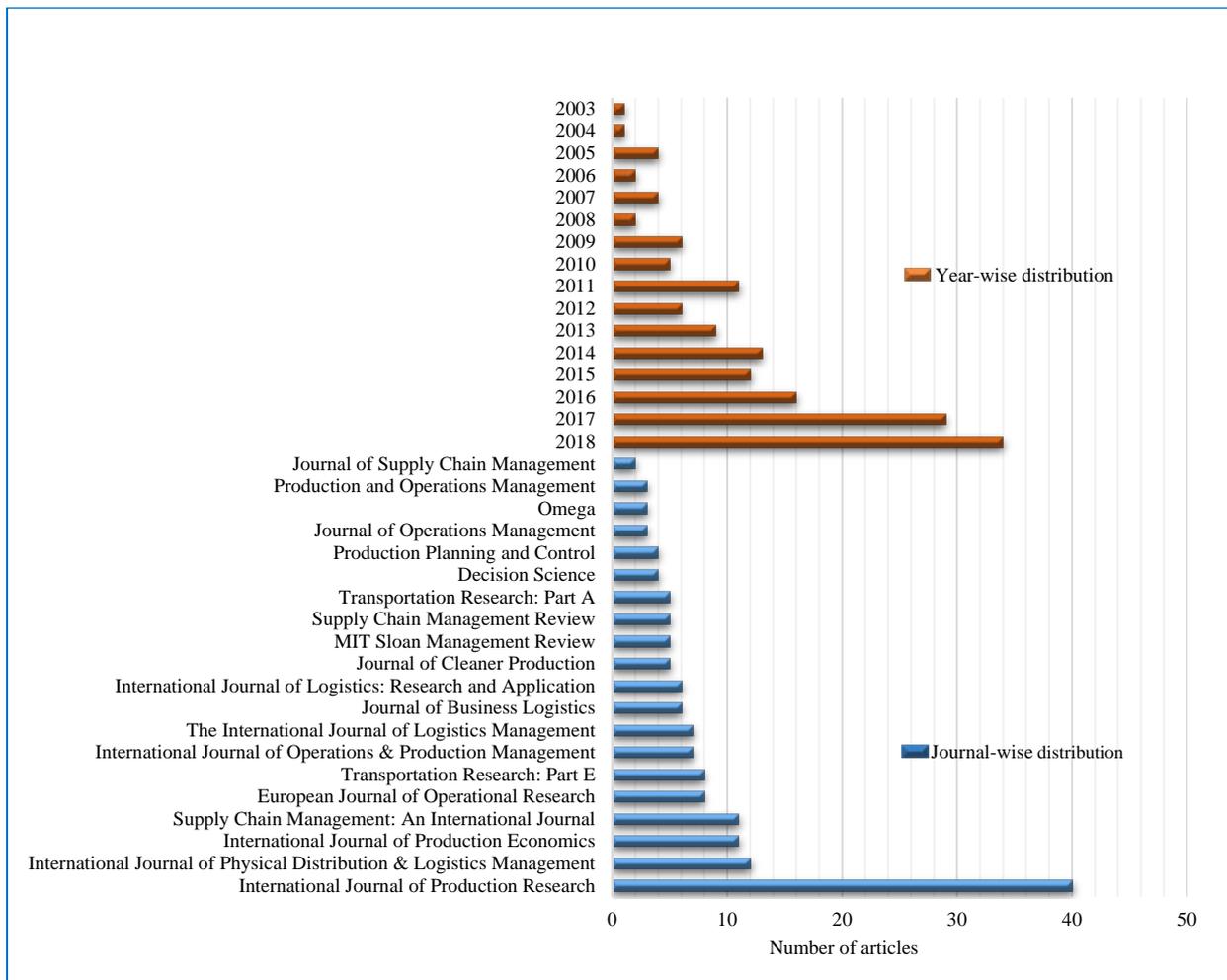**Figure 1.** A systematic and co-occurrence analysis schema

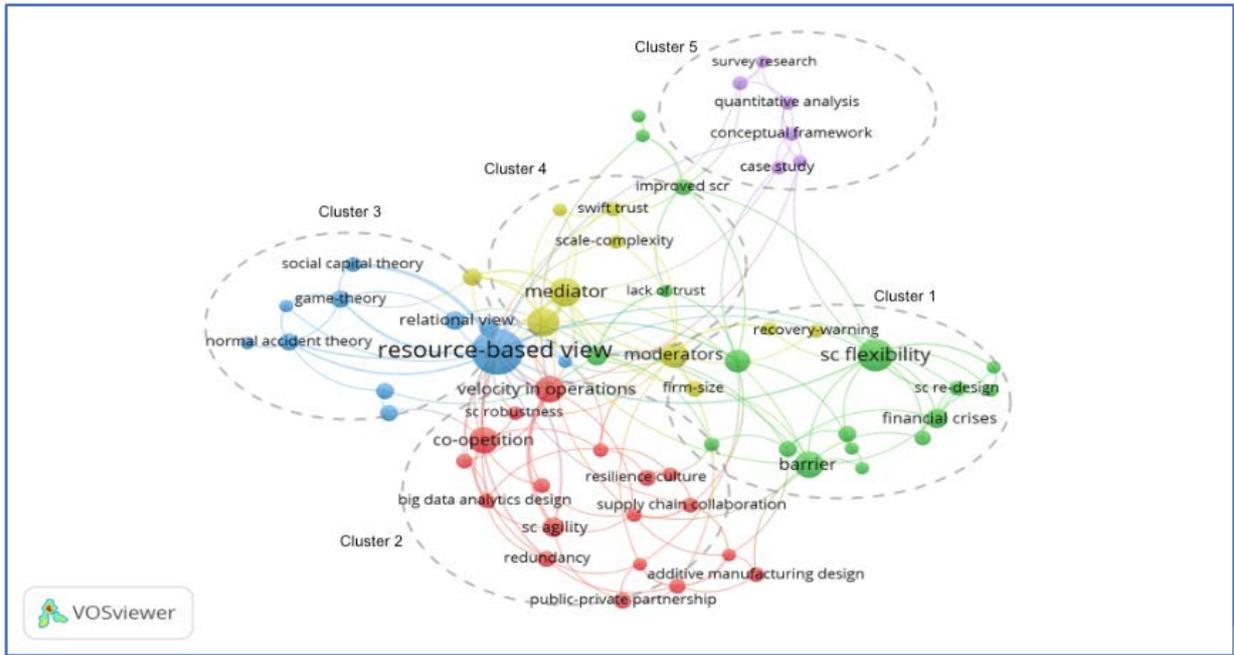**Figure 2.** Year-wise and journal-wise distribution of articles

Figure 3. VOSviewer co-occurrence analysis

Table I. Key terms and associated frequencies derived from VCA.

Key terms	Definition	Sources	Frequency
Antecedents	The factors that act as positive or negative antecedents to building SCR.		
Drivers of SCR	*Drivers, also known as enablers or elements, refer to the forces that facilitate to build SCR.*		
Preparedness	*Ability to prepare for an unforeseen incident before its occurrence.*		
SC Flexibility	*Ability to change according to the changing needs of the market demand.*	Sheffi and Rice (2005), Braunscheidel and Suresh (2009), Yang and Hsu (2018).	59 (38%)
SC Collaboration	*Ability to work cooperatively with one or more partners in a supply chain.*	Christopher and Peck (2004), Scholten et al. (2014), Singh et al. (2018).	46 (30%)
Redundancy	*Keeping excess capacity and backup system to reduce the likely impact of potential disruption.*	Sheffi and Rice (2005), Ivanov and Sokolov (2013), Yang and Hsu (2018).	30 (19%)
Resilience culture	*Strategic orientation for developing robustness and openness to change among employees of an organization.*	Christopher and Peck (2004), Williams et al. (2009), Kwak et al. (2018).	27 (17%)
Information sharing	*Real-time exchange of important and relevant data on potential threats in order to avoid potential disruptions and their impacts.*	Christopher and Peck (2004), Urciuoli et al. (2014), Dubey et al. (2018b).	25 (16%)
SC Innovation	*Creating new products, processes, and systems or refining the existing ones making them more resilient to disruptions.*	Reinmoeller and Van Baardwijk (2005), Fiksel et al. (2015), Treiblmaier (2018).	19 (12%)
Top management support	*Provision of critical resources and reinforcement by top managers to identify and deal with unforeseen incidents.*	Reinmoeller and Van Baardwijk (2005), Ponomarov and Holcomb (2009), Gunasekaran et al. (2011).	10 (6%)

Key terms	Definition	Sources	Frequency
Employees training and development	*Building specific management prowess of employees that help to reduce the likelihood of errors and thus disruptions.*	Ali et al. (2017), Bhattacharjya (2018), Ruiz-Benitez et al. (2018).	5 (3%)
Public-private partnership	*Collaboration between government agencies and private businesses to cope with potential business threats.*	Stewart et al. (2009), Ali et al. (2017), Singh et al. (2018).	4 (3%)
Co-opetition	*The situation in which firms compete and collaborate at the same time.*	Bakshi and Kleindorfer (2009), Richey (2009), Wieland and Wallenburg, (2013).	3 (2%)
Industry 4.0	*Industry 4.0 or fourth industrial revolution refers to fully automated and interconnected systems through digital technologies, including the Internet of things (IoT), cyber-physical systems, cloud and cognitive computing, 3-D manufacturing, robots, drones, etc.*	Ivanov et al. (2016), Ivanov et al. (2018), Strozzi et al. (2017)	3 (2%)
Big data analytics	*Gathering, managing, and analyzing a large and complex data set to unveil hidden patterns that could cause a disruption.*	Papadopoulos et al. (2017), Dubey et al. (2018b), Ivanov et al. (2018).	3 (2%)
Blockchain technology	*A digital ledger in which real-time transactions are recorded in a large network of globally connected computer systems.*	Ivanov et al. (2018).	1 (0.6%)
Resistance	*Ability to confront disruption and minimize losses.*		
Visibility	*Trackability and traceability of products and services from the point of production to the end customers.*	Peck (2005), Ivanov and Sokolov (2013), Dubey et al. (2018b).	49 (32%)
Robustness	*Ability to resist adverse conditions and evolve constantly.*	Blackhurst et al. (2005), Brandon-Jones et al. (2014), Gunessee et al. (2018).	43 (28%)
Agility	*Capability to sense the dynamic market changes and react quickly in*	Blackhurst et al. (2005), Wieland and	40 (26%)

Key terms	Definition	Sources	Frequency
	order to meet customers need and prevent losses, ensuring continuity of business operations.	Wallenburg (2013), Yang and Hsu (2018).	
Velocity	*The speed of reaction to a disruption.*	Peck (2005), Fiksel et al. (2015), Kwak et al. (2018).	9 (6%)
Rebound	*Ability to adapt and recover from disruption and continue operation in a normal way.*		
Resource reconfiguration/mobilization	*Redirecting internal and external resources to overcome the setback and adapt to the changing business environment.*	Braunscheidel and Suresh (2009), Ambulkar et al. (2015), Liu and Lee (2018),	48 (31%)
Adaptation	*Ability to adjust and rework after a disruption.*	Kamalahmadi and Parast (2016), Machado et al. (2018).	31 (20%)
Disruption mitigation	*Application of measures that minimize the impact of losses at the post-disruption stage and ensure the continuity of operations in a normal or even better way.*	Marley et al. (2014), Fiksel et al. (2015), Machado et al. (2018).	28 (18%)
Supply chain redesign	*Restructuring of supply chain after experiencing a disruption under the assumption that the future would be much like the past.*	Christopher and Holweg (2017), Ivanov (2018), Dubey et al. (2018b).	9 (6%)
Additive manufacturing	*The process of joining material layer upon layer from 3D model or CAD files with smart machines.*	Ivanov et al. (2018).	1 (0.6%)
Barriers	*The factors that impede a firm's ability to create SCR.*		
Flow activities (port congestion, stringent regulations), flow units (product complexities), sources of flow units (volatility of supplier's location)	*Self-explanatory*	Blackhurst et al. (2011)	1 (0.6%)

Key terms	Definition	Sources	Frequency
Resource scarcity and asset problems.	*Self-explanatory*	Pal et al. (2014).	1 (0.6%)
Lack of collaboration, lack of visibility, lack of trust and financial weakness	*Collaboration and visibility have already been defined. Trust refers to a strong believe in reliability.*	Roberta et al. (2014)	1 (0.6%)
Lack of IT integration, R&D and autonomy of control	*Insufficient information technology implementation as well as research and development. Lack of autonomy refers to the dearth of power delegation to the lower or middle managers.*	Ali et al. (2017)	1 (0.6%)
Consequences	Performance outcomes of an interactive effect of antecedents, moderators, and mediators.		
Enhanced resilience	*An increased capability to prepare, resist, and rebound from the disruption.*	Christopher and Peck (2004), Ates and Bititci (2011), Dubey et al. (2018b).	121 (78%)
Improved operational performance	*Enhanced operational functioning.*	Akgün and Keskin (2014), Stevens and Johnson (2016), Truong Quang and Hara (2017).	25 (16%)
Competitive advantage	*Ability to better perform than a competitor.*	Ponomarov and Holcomb (2009), Kwak et al. (2018), Gunasekaran et al. (2011).	7 (4%)
Supply chain's customer value	*Value of supply chain for respective customers.*	Wieland and Wallenburg (2013)	1 (0.6%)
Service performance	*Refers to how well the key stakeholders are dealt with and satisfied.*	Liu et al. (2017)	1 (0.6%)
Theoretical underpinnings	Theories employed by an article.		
Resource-based view	*Competitive advantage is gained by identifying and effectively utilizing the*	Ponomarov and Holcomb (2009), Ali et	23 (15%)

Key terms	Definition	Sources	Frequency
	firm's valuable, rare, imitable, and non-substitutable resources.	al. (2018), Yang and Hsu (2018).	
Relational view	*The joint idiosyncratic contribution of specific alliance partners generates supernormal profit in an exchange relationship.*	Wieland and Wallenburg (2013), Gabler et al. (2017), Mandal (2017).	7 (5%)
Dynamic capability	*Ability to integrate, build, and reconfigure internal and external resources to deal with a rapidly changing business environment.*	Golgeci and Ponomarov (2013), Dabhilkar et al. (2016), Chowdhury and Quaddus (2017).￼	7 (5%)
Complexity theory/ complex adaptive systems	*In a complex adaptive system, analysis of individual parts does not convey the perfect understanding of the whole system.*	Day (2014), Gunasekaran et al. (2015), Papadopoulos et al. (2017)	6 (3%)
Control theory	*Internal and external systems work against tendencies to deviate.*	Ivanov and Sokolov (2013), Ivanov et al. (2016), Dolgui et al. (2018).	5 (3%)
Contingency theory	*There is no single set of strategies. Instead, an optimal course of action depends upon the internal and external situational factors.*	Brandon-Jones et al. (2014), Ali et al. (2018), Treiblmaier (2018)	3 (2%)
Normal accident	*Socio-economic systems (i.e., systems in which there is a close interrelationship between technical infrastructures and human individuals) become more challenging to manage and control with increasing complexity.*	Marley et al. (2014), Bode and Macdonald (2017), Scheibe and Blackhurst (2018).	3 (2%)
Social capital	*Stability is the outcome of negotiated and interactive exchanges between the trading parties.*	Stewart et al. (2009), Akgün and Keskin (2014), Bhattacharjya (2018)	3 (2%)
Game theory	*A person's gain results in losses for other participants.*	Bakshi and Kleindorfer (2009), Zahiri et al. (2017).	2 (1%)

Key terms	Definition	Sources	Frequency
Social exchange	*Social change and stability are gained through the process of negotiated exchange between trading partners.*	Stevenson and Busby (2015)	1 (0.6%)
Systems theory	*A system can be more than the sum of its part. Changing one part of the system influences the other parts and ultimately, the entire system.*	Blackhurst et al. (2011)	1 (0.6%)
Moderators	The third variables that affect the strength of the relationship between SCR and consequences.		
Recovery warning	*Coordination of supply chain resources to sense an expected or realized disruption and distribute important information on disruption to relevant members within a supply chain.*	Craighead et al. (2007)	1(0.6%)
Flexibility and redundancy	*Already defined under 'antecedents'.*	Zsidisin and Wagner (2010)	1 (0.6%)
Environmental turbulence	*Quickly changing customers' demand, external conditions, technology, and market trends.*	Akgün and Keskin (2014)	1 (0.6%)
Geographical dispersion, scale complexity, differentiation, and delivery complexity.	*Geographical dispersion refers to the spread in different geographic regions. Scale complexity is the extent of the complexity of an organization or SC. Differentiation means uniqueness from others in the market. Delivery complexity means complication in distribution and logistics.*	Brandon-Jones et al. (2014)	1 (0.6%)
Product complexity	*Increasing number and variety of product to meet customers demand.*	Eckstein et al. (2015)	1(0.6%)
Firm size, consortium support, and supply chain risks.	*Firm size refers to the number of employees in an organization and/or annual revenue. It has a different measurement standard in different countries. A consortium is an association of similar businesses in an*	Ali et al. (2017).	1 (0.6%)

Key terms	Definition	Sources	Frequency
	industry. Supply chain risks are the probability of incidents associated with potential losses.		
Technological orientation	*Ability to attain and use technology in the development of a new product or service.*	Mandal (2017)	1(0.6%)
Organizational culture	*Values, customs and behaviors that guide how the member of an organization interact and approach to their work.*	Altay et al. (2018)	1 (0.6%)
Top management commitment	*Assurance to Provide necessary resources required for dealing with unforeseen incidents.*	Dubey et al. (2018a).	1 (0.6%)
Mediators	The mechanisms through which an independent variable influences SCR.		
Innovation magnitude	*The extent of impact and change incurred by innovation on the functioning and structure of a firm.*	Golgeci and Ponomarov (2013)	1 (0.6%)
Product innovativeness	*Creating a new product/service or refining the existing one by adding new features.*	Akgün and Keskin (2014)	1 (0.6%)
Visibility	*Already defined under 'resistance'.*	Brandon-Jones et al. (2014)	1 (0.6%)
Recognition, diagnosis, development, implementation	*Identification, evaluation, improvement and implementation of SCR practices.*	Bode and Macdonald (2017)	1 (0.6%)
Swift trust	*A quick belief on the trading partners.*	Dubey et al. (2018b)	1 (0.6%)
Agility, integration, supply chain engineering	*Agility has already been defined under 'resistance' in this table. Integration is a combination of a part of the system together. Supply chain engineering means developing the structure of a supply chain.*	Liu et al. (2017)	1 (0.6%)
Security management	*Improving the safety of an organization.*	(Yang and Hsu, 2018)	1 (0.6%)
Research methods	The approaches to collect information and data in order to uncover the hidden		

Key terms	Definition	Sources	Frequency
	patterns and suggest new or better ways of doing business.		
Conceptual	*Without empirical validation*	Rice and Caniato (2003), Ponomarov and Holcomb (2009), Ivanov et al. (2018).	33 (21%)
Simulation/mathematical modeling	*Creating and analyzing digital prototypes of the model in order to predict real-world performance.*	Datta et al. (2007), Cardoso et al. (2015), Beheshtian et al. (2018)	48 (31%)
Qualitative case studies	*An in-depth qualitative study of an individual or a group of individuals.*	Blackhurst et al. (2005), Gunasekaran et al. (2011), Scheibe and Blackhurst (2018).	39 (25%)
Survey-based studies	*Collection, analysis, and interpretation of a large quantitative data set.*		
Single method	*Involve only quantitative studies.*	Braunscheidel and Suresh (2009), Mandal (2012), Zhang et al. (2018).	31 (20%)
Mixed-methods	*Involve both qualitative and quantitative data.*	Pettit et al. (2013), Ali et al. (2018), Treiblmaier (2018).	4 (3%)