



International Journal of Logistics Research and Applications

A Leading Journal of Supply Chain Management

ISSN: 1367-5567 (Print) 1469-848X (Online) Journal homepage: <https://www.tandfonline.com/loi/cjol20>

An Integrative approach to supply chain disruption risk and resilience management: a literature review

Mansoor Shekarian & Mahour Mellat Parast

To cite this article: Mansoor Shekarian & Mahour Mellat Parast (2020): An Integrative approach to supply chain disruption risk and resilience management: a literature review, International Journal of Logistics Research and Applications, DOI: [10.1080/13675567.2020.1763935](https://doi.org/10.1080/13675567.2020.1763935)

To link to this article: <https://doi.org/10.1080/13675567.2020.1763935>

 View supplementary material 

 Published online: 15 May 2020.

 Submit your article to this journal 

 View related articles 

 View Crossmark data 



An Integrative approach to supply chain disruption risk and resilience management: a literature review

Mansoor Shekarian^a and Mahour Mellat Parast^b

^aLundquist College of Business, University of Oregon, Eugene, OR, USA; ^bIra A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, USA

ABSTRACT

A fundamental question in supply chain resilience is identifying its antecedents and investigating the relative importance of each antecedent in improving resilience to supply chain disruptions. In this paper, a comprehensive systematic literature review is conducted to assess the impact of each of the most widely known practices to enhance resilience (flexibility, agility, redundancy, and collaboration) on mitigating each type of supply chain disruption (demand, supply, process, control, and environmental disruptions). The literature review found that collaboration has been identified by the literature as the most important strategy to cope with control disruptions, and flexibility has been identified by the literature as the most important strategy to cope with demand, supply, process, and environmental disruptions. A framework is then developed for identifying the appropriate antecedents in improving resilience to different types of supply chain disruptions.

ARTICLE HISTORY

Received 21 June 2019
Accepted 28 April 2020

KEYWORDS

Supply chain resilience; supply chain risk management; risk types; flexibility; agility; collaboration; redundancy; literature review

1. Introduction

In today's rapidly changing environment, supply chains are more easily exposed to risks due to factors such as increased globalisation, higher customer expectations, environment volatility, and the occurrence of internal and external risk events (Zhang, Vonderembse, and Lim 2002; Craighead et al. 2007; Chen, Sohal, and Prajogo 2013; Ivanov, Sokolov, and Dolgui 2014; Aqlan and Lam 2015). Scholars and practitioners emphasize that managing risk and disruption in the supply chain is a crucial capability for firms, in order to compete in the today's increasingly turbulent and unpredictable marketplace (Melnik et al. 2009; Colicchia and Strozzi 2012; Nooraie and Parast 2016; Yang, Pan, and Ballot 2017).

Supply chain risk management (SCRM) is 'the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity' (Tang 2006a, 453). According to Aqlan and Lam (2015), SCRM is an asymmetric approach for identifying, assessing, and monitoring the risks for potential disruption in a supply chain network, in order to mitigate the negative effects of disruptions on supply chain operations. According to Butner (2010), supply chain executives at IBM believe that SCRM is the second-most important issue for their company.

A general categorisation of supply chain risks is to classify risks into disruption risks and operational risks (Kleindorfer and Saad 2005; Tang 2006a; Chen, Sohal, and Prajogo 2013). Disruption risks typically are defined as unplanned events that restrict a supply chain system; they may result

from man-made or natural events disasters such as economic downturns, technology changes, hurricanes, labour strikes, and terrorist attacks (Parast and Shekarian 2019). Operational risks are more about supply-demand coordination events, which may result from inadequate or failed processes, control, people, or systems (Christopher and Peck 2004; Lockamy and McCormack 2010; Gurning and Cahoon 2011; Wakolbinger and Cruz 2011; Ghadge, Dani, and Kalawsky 2012; Chen, Sohal, and Prajogo 2013; Nooraie and Parast 2015; Yang, Pan, and Ballot 2017). Thus, operational risks are relatively more controllable than disruption risks. Moreover, catastrophic events such as 9/11 in 2001, the tsunami in 2004, hurricane Katrina in 2005, hurricane Harvey in Houston in 2017, and hurricane Maria in Puerto Rico in 2017 are motivation for supply chain researchers to consider supply chain risk and its effects on the design of supply chains (Chopra and Sodhi 2004; Tang 2006a; Thun, Drüke, and Hoening 2011; Heckmann, Comes, and Nickel 2015; Ho et al. 2015; Kamalahmadi and Parast 2016a).

Supply chain resilience (SCRES) reduces the impact of disruptions by identifying strategies that allow a supply chain to react to a disruption while recovering to its original functional state or better. SCRES has received more attention in recent years as one of the main characteristics of a firm to improve responsiveness to unexpected dynamics in the business environment (Ponomarov and Holcomb 2009; Ates and Bititci 2011; Borekci, Rofcanin, and Gürbüz 2015; Kamalahmadi and Parast 2016a). Melnyk et al. (2014) asserted that SCRES is at the heart of current supply chain management thinking. Based on Tukamuhabwa et al. (2015), more than 80% of companies were concerned about their SCRES in 2013. Hence, SCRES is of a great interest for firms and organisations (Jüttner and Maklan 2011; Borekci, Rofcanin, and Gürbüz 2015; Scholten and Schilder 2015; Ivanov 2018).

This study aims to address these key questions in SCRM and SCRES:

- (1) What is the current state of research in SCRES and the management of supply chain disruption risks?
- (2) Regarding the various sources of disruption risk in supply chains (supply risk, demand risk, environment risk, process risk, and control risk), in what SCRES enhancers should a firm invest as the best strategy to build a resilient supply chain?
- (3) What are the gaps in current research that future research should address?

This study synthesises the accumulated findings to address the research questions by reviewing the articles published in major academic and practitioners' journals from 2000 to 2017 using a systematic literature review (SLR) process (Ho et al. 2015; Tukamuhabwa et al. 2015; Kamalahmadi and Parast 2016b; Ali, Mahfouz, and Arisha 2017).

The remainder of this study is organised in the following sections. Section 2 is a review of the literature on SCRES and the SCRES enhancers: flexibility, agility, collaboration, and redundancy. Section 3 is a discussion of the research methodology. Section 4 presents statistics about the characteristics of each research study, then provides an overview of research on SCRES definitions and antecedents by considering each type of disruption risk. Section 5 is a discussion about the major findings of this study. Section 6 discusses the limitations of this research along with recommendations for future research. Section 7 presents the conclusions of this study.

2. Literature review

Several literature review studies have been conducted on SCRES. Ali, Mahfouz, and Arisha (2017) used an SLR approach to analyze the concept of SCRES within a concept mapping framework to seek conceptual clarity, with an emphasis on the SCRES definition, essential elements, and managerial practices. Their results identified three major constructs used to define SCRES: phases of resilience, resilience strategies, and the capabilities needed to be resilient. In addition, they indicated that the emphasis of capabilities needed for SCRES in the current literature is on the ability to recover and adapt, while less attention is paid to the capacity to anticipate and learn from experience. Kochan and

Nowicki (2018) used the logic of context – interventions-mechanisms-outcomes to conduct an SLR of 228 peer-reviewed studies; the authors presented a focused review of the SCRES literature, the studies' relationship to SCRES outcomes, and the theoretical mechanisms underpinning this relationship. Their findings suggested that in SCRES research, there is a shift from resilience definitions and principles to resilience measurement. Moreover, they indicated that the number of empirical studies has increased in recent years. However, they found a lack of field studies, longitudinal studies, studies that use secondary data, and theoretical frameworks to explain SCRES phenomena. Hohenstein et al. (2015) conducted an SLR of 67 peer-reviewed studies; the authors emphasized four phases of SCRES: readiness, response, recovery, and growth. They found that the SCRES definitions of most researchers focused on response and recovery to unexpected disturbances, with less focus on readiness and growth. In addition, they found that supply chain flexibility, redundancy, collaboration, and agility were the SCRES elements most frequently declared in the literature. Finally, Durach, Wieland, and Machuca (2015) reviewed 94 studies to provide the groundwork for an emerging theory of supply chain robustness as a dimension of SCRES. They found that visibility, risk management orientation, and reduced network complexity have been the main predictive antecedents of supply chain robustness.

To provide a review of the effect of SCRES drivers (resilience enhancers) on mitigating supply chain disruptions, this study examines the impact of each of four resilience enhancers (flexibility, agility, collaboration, and redundancy) on mitigating each of five types of supply chain disruptions (demand, supply, process, control, and environmental disruptions). This research differs from previous studies in several ways: first, instead of conducting a review of the concept of resilience (Ali, Mahfouz, and Arisha 2017; Kochan and Nowicki 2018) or reviewing its definition, elements, and capabilities (Durach, Wieland, and Machuca 2015; Hohenstein et al. 2015), to the best of our knowledge, this is the first study to investigate the effect of SCRES enhancers on mitigating each type of supply chain disruption. This study indicates which enablers of SCRES (flexibility, agility, collaboration, and redundancy) have been identified by previous studies as the most important organisational practices to mitigate each type of supply chain disruption (demand, supply, process, control, and environmental). In addition, this study thoroughly covers peer-reviewed journal articles from 2000 through 2017, using five phases in collecting publications: (1) question formulation, (2) locating studies, (3) article selection and evaluation, (4) analysis and synthesis, and (5) reporting and using results.

In the following section, SCRM is first discussed and a framework is presented to categorise various sources of risk. This is followed by a review of SCRES and flexibility, agility, collaboration, and redundancy as the most important enhancers of SCRES.

2.1 Supply chain risk

The literature proposes several categorizations of supply chain risks: 1) corporate governance viewpoint, financial risk viewpoint, and multi-level complex system viewpoint (Peck 2004); 2) macro risk and micro risk (Ho et al. 2015); 3) catastrophic risks and operational risks (Sodhi, Son, and Tang 2012); 4) disruption risks and operational risks (Tang 2006a; Chen, Sohal, and Prajogo 2013); 5) internal disruption risks and external disruption risks (Supply Chain Risk Management Council 2011); and 6) internal to the firm (process risk and control risk), external to the firm but internal to the supply chain network (demand risk and supply risk), and external to the network (environmental risk) (Christopher and Peck 2004).

Studies such as Samvedi, Jain, and Chan (2013), Leat and Giha (2013), Tang and Tomlin (2008), and Christopher and Peck (2004) showed that there is not a consensus categorisation and definition for each type of supply chain disruption risk. Therefore, for this research, their definitions for supply chain sources of risk are extended to these five types (Figure 1):

Demand Risk: This type of risk involves (1) the potential difference between actual demand and forecasted demand, and (2) potential disturbances in the flow of products and information within

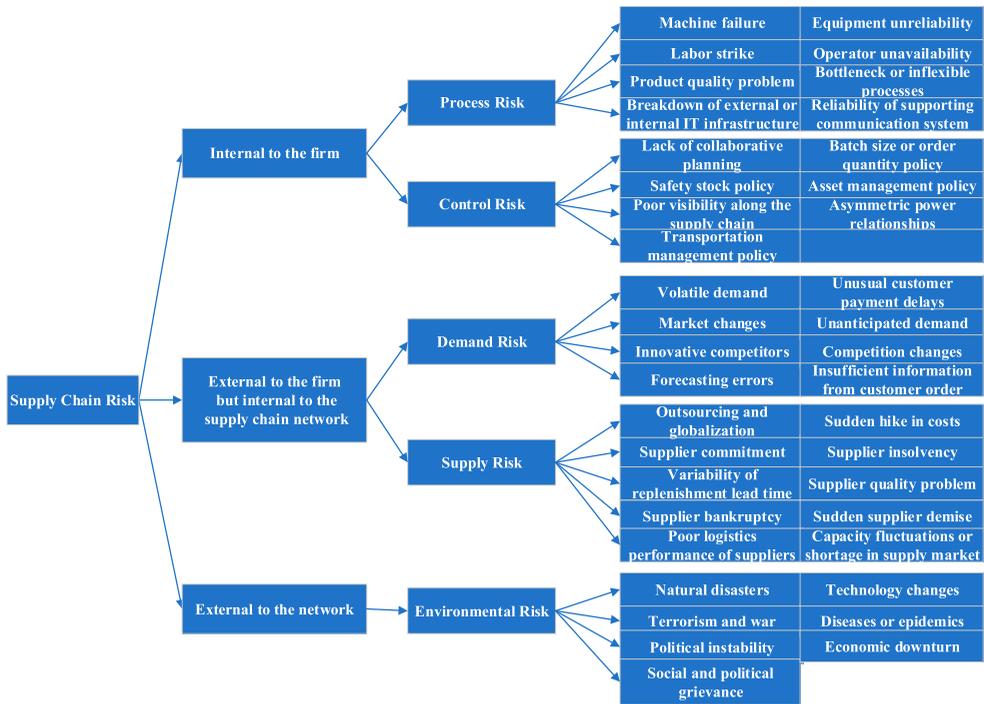


Figure 1. Supply chain sources of risk (adapted from Samvedi, Jain, and Chan (2013)).

the network or between the focal firms and the market. These are some sources of demand risk: unanticipated or volatile demand, insufficient or distorted information from customers about orders or demand quantities, unusual customer payment delays, market changes, forecasting errors, and innovative competitors.

Supply Risk: This type of risk involves (1) potential deviations in incoming supplies in terms of time, quality, and quantity, and (2) potential disturbances to the flow of products and information from within the network, upstream of the focal firms. Supply chain managers aim to reduce the cost of managing multiple suppliers and to foster better supplier relationships. These are some examples of sources of supply risks: poor logistics performance of suppliers (e.g. in delivery dependability, or in capacity to fill orders); supplier quality problems; sudden demise of a supplier (e.g. due to bankruptcy); poor logistics performance of logistics service providers; capacity fluctuations or shortages in the supply markets; outsourcing and globalisation issues; supplier commitment; and variability of replenishment lead time.

Process Risk: Process risk involves potential deviations from producing the desired quality and quantity at the right time. This type of risk includes the quality, time, and capacity risks that are associated with in-bound and out-bound logistics and in-house operations. Sources of process risk are the two main types of variability in a manufacturing system: process variability and flow variability. Process risk is also related to disruption in internally owned assets and the reliability of the supporting communication system, transportation system, and infrastructures. These are some additional sources of process risk: downtime or loss of own production capacity due to local disruption (e.g. labour strikes, fire, explosion, industrial accidents); downtime or loss of own production capacity due to technical reasons (e.g. machine breakdowns, bottlenecks, inflexible processes, equipment unreliability, lengthy set-up times); perturbation or breakdown of internal IT infrastructure (e.g. caused by computer viruses, software bugs); perturbation or breakdown of external IT infrastructure; operator unavailability; and product quality problems.

Control Risk (Network Risk): Control risk or network risk involves the assumptions, rules, systems, and procedures that govern how an organisation exerts control over its processes. Examples of sources of this type of risk are order quantities, batch sizes, safety stock policies, and the procedures that govern asset and transportation management. These kinds of risks can also occur for a supplier who is vertically integrated when a direct competitor of the customer firm forces termination of the relationship (Chopra and Sodhi 2004). Additional examples of sources of control risk or network risk are asymmetric power relationships, lack of collaborative planning and forecasts, and poor visibility along the supply chain.

Environmental Risk: These are risks external to the firm. They may affect a particular value stream (e.g. product contamination) or any node or link through which the supply chain passes (affecting it by an accident, direct action, extreme weather, or natural disaster). Examples of sources of environmental risks are political instability, terrorism, war, diseases or epidemics, natural disasters, social and political grievances, economic downturns, and technology changes.

Based on the above definitions for various sources of risk in a supply chain, the following classification is proposed for this study (Figure 1).

One of the central questions in SCRM is to identify organisational capabilities that make a firm more responsive to supply chain disruptions (Tukamuhabwa et al. 2015; Behzadi et al. 2018; Ivanov et al. 2017; Jain et al. 2017). Using the categorisation shown in Figure 1 of the sources of risk in a supply chain, this study investigates how organisations can mitigate the negative effect of supply chain disruptions through investment in organisational capabilities; this is discussed under SCRES.

2.2 Supply chain resilience (SCRES)

Resilience in a supply chain can be defined as a firm's ability to withstand a disruption and recover from the disruption to its original state, or even move toward a more desirable state after being disturbed (Christopher and Peck 2004). Pettit, Croxton, and Fiksel (2013) defines resilience with the 'four Rs': robustness, resourcefulness, recovery, and review. To improve SCRES, diverse strategies have been recommended in the literature (Tang 2006a; Colicchia, Dallaria, and Melacini 2011; Urciuoli et al. 2014). While resilience enhancers can include a wide range of organisational practices, the literature recognises the impact of flexibility, agility, collaboration, and redundancy strategies as the most important organisational capabilities to improve a firm's responsiveness to supply chain disruptions (Christopher and Peck 2004; Sheffi and Rice 2005; Tomlin 2006; Jüttner and Maklan 2011; Ponis and Koronis 2012; Sodhi, Son, and Tang 2012; Pettit, Croxton, and Fiksel 2013; Simchi-Levi, Wang, and Wei 2018; Das and Lashkari 2015; Tukamuhabwa et al. 2015; Kamalahmadi and Parast 2016a; Jain et al. 2017; Yang, Pan, and Ballot 2017). Christopher and Peck (2004) recommended the inclusion of resource redundancy, agility, supplier flexibility, and a collaborative planning approach (as a part of risk management culture) for creating SCRES. Tukamuhabwa et al. (2015) indicated there are twenty-four different strategies for achieving SCRES. They showed that increasing flexibility, improving supply chain agility, forming collaborative supply chain relationships, and creating redundancy have the most effect on improving SCRES. Stevenson and Spring (2007) showed that there are twenty-one dimensions for supply chain flexibility. Chan, Ngai, and Moon (2017) showed that strategic flexibility and manufacturing flexibility can enhance supply chain agility, and Shekarian, Nooraie, and Parast (2019) showed that volume and supplier flexibility can enhance supply chain agility. Therefore, we cannot conclude that all dimensions of supply chain flexibility can enhance supply chain agility. For this purpose, this study differentiates between supply chain flexibility and supply chain agility. In the following sections, each antecedent of SCRES (flexibility, agility, collaboration, and redundancy) is briefly discussed.

2.3 Flexibility

'Flexibility refers to the ability of a firm to respond to long-term or fundamental changes in the supply chain and market environment by adjusting the configuration of the supply chain' (Parast and Shekarian 2019, 380). This measure indicates the flexibility of a firm in responding to environmental changes, demand changes, supply changes, and technology changes (Overby, Bharadwaj, and Sambamurthy 2006; Li, Goldsby, and Holsapple 2009; Blome, Schoenherr, and Eckstein 2014; Dominik et al. 2015; Parast and Shekarian 2019). Several studies have indicated the important role of flexibility in enhancing SCRES (Sheffi 2005; Christopher and Peck 2004; Das and Lashkari 2015; Tukamuhabwa et al. 2015; Tang and Tomlin 2008). Das (2011) asserted that it is an established fact that the inclusion of effective flexibility measures makes a business more responsive by resolving most supply chain uncertainty issues. Fang, Li, and Xiao (2012) asserted that through flexible system organisation, a resilient supply network can be realised both effectively and efficiently. Also, flexibility creates SCRES by enhancing prompt adaptability during turbulence (Christopher and Holweg 2011).

2.4 Agility

Agility is described as the ability to efficiently change operating states as a response to environmental uncertainty or volatile market conditions (Prater, Biehl, and Smith 2001; Narasimhan, Swink, and Kim 2006; Faisal, Banwet, and Shankar 2006a; Lim, Mak, and Shen 2017; Parast and Shekarian 2019). Agility is one of the most powerful ways to achieve a resilient supply chain capable of rapid responses to changing conditions (Christopher and Peck 2004). Tukamuhabwa et al. (2015) indicated that agility is one of the most important capabilities to enhance SCRES. Braunscheidel and Suresh (2009) asserted that agility is critical for a timely and efficient response to mitigate disruptions. They defined agility as a risk management initiative that enables a firm to respond rapidly to market changes and potential or actual disruptions in the supply chain. Supply chain managers can decrease the risks that are related to inventory management by dealing with responsive suppliers (Chopra and Sodhi 2004).

2.5 Collaboration

'Supply chain collaboration refers to the ability to work efficiently with other entities for mutual benefit in areas such as forecasting, postponement, and risk sharing' (Parast and Shekarian 2019, 380). In a collaborative culture, supply chain partners openly communicate and work together to share information, in order to improve supply chain visibility, reduce supply chain uncertainty, and enhance competitiveness (Chen, Sohal, and Prajogo 2013). Organisations need to realise the critical role of collaboration in enhancing the competitive advantage and reducing the overall cost and uncertainty in a supply chain (Carter and Rogers 2008; Gold, Seuring, and Beske 2010; Parast and Shekarian 2019). Moreover, a high level of collaboration across a supply chain can help mitigate disruption and reduce risk (Chen, Sohal, and Prajogo 2013; Li et al. 2015; Jain et al. 2017 Parast and Shekarian 2019). Beske and Seuring (2014) maintained that collaboration can be understood as one step further than cooperation. According to Swierczek (2014), supply chain integration is a strategic collaboration of both intra-organizational and inter-organizational processes. He believes that cooperation, collaboration, and coordination between supply chain members provide an extensive integration in the supply chain. Decision synchronisation and incentive alignment are two major contributions of collaboration in a supply chain; they are essential for successfully responding to disruption in the supply chain (Jain et al. 2017).

2.6 Redundancy

'Redundancy involves the strategic and selective use of spare capacity and inventory that can be invoked to cope with a crisis, such as demand surges or supply shortages' (Parast and Shekarian 2019, 380). Sheffi and Rice (2005) recommended that building redundancy is an effective option to create resilience and enhance recovery from disruptions. Kamalahmadi and Parast (2017) showed how implementation of three types of redundancy strategies (inventory, backup suppliers, and protected suppliers) can improve a firm's performance in a turbulent and complex business environment that requires mitigating the effects of supply chain disruption.

3. Research methodology

In this research, an SLR methodology is adopted to gain deep knowledge about SCRES for informing researchers and practitioners. An SLR entails a series of techniques to minimise bias and error, improve the clarity of scholarly communication, increase internal validity, and create transparency through an auditable process (Tranfield, Denyer, and Smart 2003; Denyer and Tranfield 2009). In addition, the robustness of the SLR methodology in combining evidence from existing studies can create new knowledge through rigour in criteria for selection, the analyses, and the reporting (Rousseau, Manning, and Denyer 2008; Ali, Mahfouz, and Arisha 2017; Kochan and Nowicki 2018). The methodology follows five review phases to improve the validity and quality of the SLR findings: (1) formulating questions, (2) locating articles, (3) selecting and evaluating articles, (4) analyzing articles and synthesising findings, and (5) reporting and using results.

Phase 1: Formulating questions

The first step of an SLR is to define the scope of the study and to avoid ambiguity by defining and formulating the review question (Rousseau, Manning, and Denyer 2008; Booth et al. 2012; Ali, Mahfouz, and Arisha 2017). This study aims to answer the following research question: How can SCRES antecedents cope with various sources of disruption risks? To provide more insight into the research question, three sub-questions are formulated:

- What are the constructs used to define SCRES and SCRM?
- How can SCRES antecedents be used to mitigate various sources of disruption risks?
- What are the managerial practices needed to support SCRES enhancers?

Phase 2: Locating articles

The purpose of this phase is to create a comprehensive list of core contributions in relation to the review question (Denyer and Tranfield 2009). In line with Kamalahmadi and Parast (2016b), this study uses the widely accepted quality rating published by the Association of Business Schools, UK, as Academic Journal Guide 2015 (AJG 2015). In addition, three different domains of management are considered for this research: Operations Management (OM), Operations Research and Management Science (OR/ MS), and General Management (GM). Table 1 identifies the journals where the reviewed articles were published. Each journal's AJG 2015 ranking is on a scale of 1–4, where 4 is highest.

In order to identify and collect the publications for this research, major business and management databases, including Emerald, Elsevier Science Direct, ABI/ Inform Global ProQuest, Wiley, INFORMS, Google Scholars, Springer, Taylor and Francis Online, along with each journal of Table 1 were used (Tukamuhabwa et al. 2015; Kamalahmadi and Parast 2016b; Ali, Mahfouz, and Arisha 2017).

A total of 20 keywords were identified for this research. The keywords consisted of the following terms: 'Supply chain' AND ('Flexibility/ Flexible/ Flexib*¹', 'Agility/ Agile/ Agil*', 'Redundancy/ Redundant/ Redundan*', 'Collaboration/ Collaborate/ Collaborat*', or 'Cooperation/ Cooperate/ Cooperat*') AND ('Disruption', 'Uncertain', 'Risk', or 'Resilien*'). The selected keywords were

Table 1. List of journals reviewed and their AJG 2015 rankings.

List of Journals	AJG Ranking
Operations Management	
Production and Operations Management (POM)	4
Journal of Operations Management (JOM)	4
International Journal of Operations and Production Management (IJOPM)	4
International Journal of Production Research (IJPR)	3
Manufacturing and Service Operations Management (MSOM)	3
International Journal of Production Economics (IJE)	3
IEEE Transactions on Engineering Management (IEEE-TEM)	3
Journal of Supply Chain Management (JSCM)	3
Supply Chain Management: An International Journal (SCM)	3
Journal of Business Logistics (JBL)	2
Operations Research and Management Science	
Management Science (MS)	4
Operations Research (OR)	4
European Journal of Operational Research (EJOR)	4
Decision Science Journal (DSJ)	3
General Management	
Harvard Business Review (HBR)	3
MIT Sloan Management Review (SMR)	3
California Management Review (CMR)	3

then used to construct search strings with Boolean connectors (e.g. OR, AND) using a combination of the search fields in the article titles, abstracts, and keywords, as well as in the full text (Table 2). The time horizon for locating studies was from 2000 to 2017 (December). According to Kamalahmadi and Parast (2016b), since the concept of SCRES was not discussed much before 2000, publications starting with the year 2000 were considered for this research.

Phase 3: Selecting and evaluating articles

A list of inclusion criteria (Table 3) for reading the titles, keywords, and abstracts of each paper was used in selecting the articles (Burgess, Singh, and Koroglu 2006; Ali, Mahfouz, and Arisha 2017). A total of 374 papers were identified in this step. The resulting articles were subjected to these four steps (Tukamuhabwa et al. 2015; Kamalahmadi and Parast 2016b): First, all the articles were cross-checked in order to eliminate duplicate results retrieved from different databases. This reduced the number of articles from 374 to 321. Second, based on the inclusion criteria, the articles were screened and reviewed. This involved conducting an initial check with regard to the title, abstract, and keywords identified in the articles. This step retrieved the papers related to SCRES strategies (flexibility,

Table 2. Keywords and search strings.

Construct	Keywords	Search strings	Database
Supply chain resilience	Supply chain resilience	AB supply chain AND TX (resilien* OR risk OR disruption OR uncertain) AND TX	Emerald, Elsevier Science Direct, ABI/Inform Global ProQuest, Wiley,
Supply chain risk management	Resilient supply chain	(flexib* OR agil* OR collaborat* OR cooperat* OR redundan*)	INFORMS, Google Scholars, Taylor and Francis Online (along with each journal of Table 1)
	Supply chain risk management		
	Supply chain risk		
	Supply chain flexibility		
	Supply chain agility		
	Supply chain collaboration		
	Supply chain cooperation		
	Supply chain redundancy		

*Note: AB = abstract and TX = all text

Table 3. Inclusion criteria for SCRES

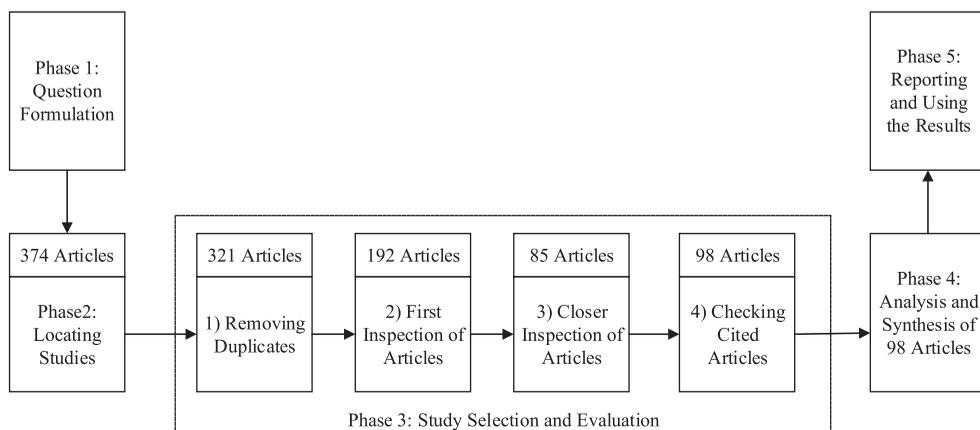
Inclusion criteria	Rationale
- Peer-reviewed studies that are published in the journals of Table 1.	- High-ranking journals are believed to be of higher quality.
- Selection of papers published during 2000–2017	- The year 2000 is selected as the starting point, since the concept of resilience, especially SCRES, was not discussed much before 2000 (Kamalahmadi and Parast 2016b).
- Summary must show clear indication of dimensions and antecedents of SCRES	- The purpose of the study is to investigate the effect of various antecedents of SCRES on mitigating supply chain disruptions.
- Articles must be written in English	- English is the dominant research language in the field of supply chain management.
- Different types of research considered (e.g. theoretical/ conceptual, modelling/ simulation, case study, survey)	- The focus of the research is to investigate various types of research and synthesise their approaches to the concept of SCRES.

agility, collaboration, and redundancy). This reduced the number of articles from 321 to 192. Third, the introduction, conclusion, and implication sections of the 192 papers were reviewed to retrieve the papers that investigated the effect of each type of SCRES strategy on mitigating each source of disruption risk (demand, supply, control, process, and environmental disruption). This step helps to identify which strategy of SCRES enhancer (supply chain flexibility, agility, collaboration, or redundancy) has been discussed to mitigate different sources of supply chain disruption (demand, supply, process, control, or environmental). In order to clearly identify each source of disruption risk, the proposed framework (Figure 1) and the associated definitions for each source of disruption risk were used. This reduced the number of articles to from 192 to 85. Finally, by checking the references and citations in each of the 85 papers, the number of publications was increased to 98. Therefore, this procedure resulted in 98 quality research publications that are the basis of the literature review presented in this study. Figure 2 shows the selection and evaluation process.

Phase 4: Analyzing articles and synthesising findings

According to Tranfield, Denyer, and Smart (2003), an SLR should synthesise the findings of each study into a new arrangement. The objective of this phase is to analyze and synthesise the selected 98 articles so as to develop new knowledge and insights about the topic that were not evident through reading each article separately (Denyer and Tranfield 2009; Ali, Mahfouz, and Arisha 2017). The extracted information includes the definition of each SCRES enhancer and its effect on each type of supply chain disruption risk driver, along with strategies for building a resilient supply chain. The synthesis was carried out by making associations between the themes identified in each study.

Phase 5: Reporting and using the results

**Figure 2.** Overview of the research methodology.

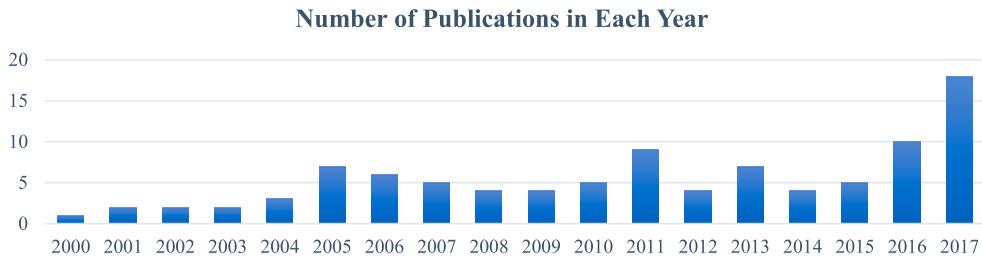


Figure 3. Distribution of the final 98 journal articles in SCRES (2000–2017).

An SLR approach summarises the literature to make the findings more understandable for practitioners and researchers (Denyer and Tranfield 2009). The following sections outline these findings on the current state of SCRES studies and the results relating to the three sub-questions posed during Phase 1.

4. Summary of results

4.1 Characteristics of publications

Figure 3 represents the distribution of the 98 publications that are related to SCRES and were obtained based on the final results of the SLR in this study. Data indicates that between 2000 and 2004, when the concept of SCRES emerged, the number of articles in SCRES gradually increased. This aligns with Ali, Mahfouz, and Arisha (2017), Kamalahmadi and Parast (2016b), Tang and Musa (2011), and Pereira, Christopher, and Silva (2014). In addition, the figure shows a small variation in the number of publications until 2011, when there is a substantial increase in the number of publications on SCRES. Figure 3 also shows that most SCRES articles were published between 2009 and 2017, providing evidence for the growing body of literature and the importance of SCRES in the research. Moreover, the figure shows a dramatic increase around 2017 in the number of publications on SCRES; the research for this paper was conducted at the end of 2017.

Figure 4 shows categories of journal articles: 77% of the articles are from the category of Operations Management (OM), 17% are from Operations Research/Management Science (OR/ MS), 5% are from General Management (GM), and 1% of the articles are from the category of Others (Marketing). These findings align with Kamalahmadi and Parast (2016b) and Ghadge, Dani, and Kalawsky (2012), which indicate that SCRES and the SCRM context have been represented mostly within the OM domain.

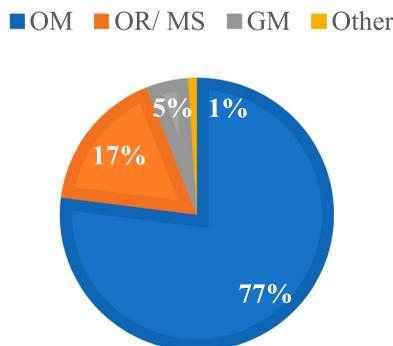


Figure 4. The categories of journal articles.

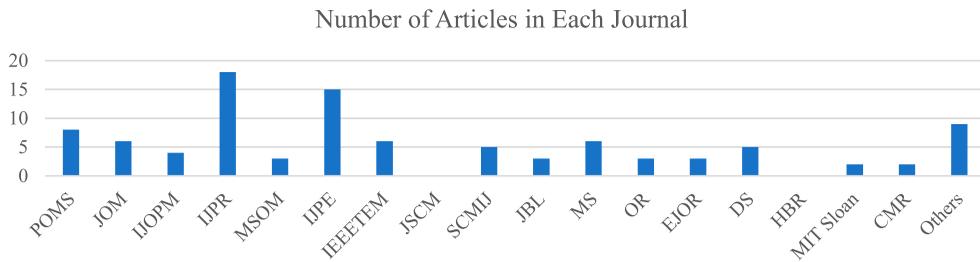


Figure 5. Distribution of articles in journals.

Figure 5 shows the journal-wise distribution of the 98 articles. According to this figure, the majority of the articles are from IJPR (18 articles), followed by IJPE (15 articles), Others (9 articles), and POMS (8 articles). 'Others' in this figure account for 'International Journal of Physical Distribution & Logistics Management', 'International Journal of Logistics Management', 'Business Process Management', 'OMEGA', 'International Journal of Logistics Research and Applications', and 'Industrial Marketing Management'. All of these journals are from the OM category, except the last one, which is from the Marketing category.

Among the articles, 43% emphasized flexibility, 27% collaboration, 19% agility, and 11% redundancy as the important capabilities of SCRES in mitigating supply chain disruptions (Figure 6).

In the literature, various research methodologies have been used to study SCRES (Burgess, Singh, and Koroglu 2006; Kochan and Nowicki 2018). According to Seuring and Muller (2008), the dominant approaches in the operations and supply chain management literature are conceptual/ theoretical work, case studies, surveys, and modelling work. Figure 7 shows a categorisation of the 98 reviewed SCRES articles based on their research method: theoretical and conceptual papers (37%), modelling/ simulation papers (34%), case study papers (17%), and survey papers (12%). Note that there were no papers in the category of literature review to discuss the impact of SCRES enhancers on supply chain disruption risks. From Figure 7, it is clear that the dominant research methods are theoretical/conceptual studies and modelling/ simulation studies.

In the following sections, this study discusses the role of each of the SCRES enhancers (flexibility, agility, collaboration, and redundancy) on mitigating each type of supply chain disruption (demand, supply, process, control, and environmental), using the categories from Figure 1. A summary of all studied papers is provided in Table 4 in the Appendix.

4.2 Demand risk

This study first investigates the effect of antecedents of SCRES on mitigating demand disruption, as one of the supply chain risk drivers. This type of risk is the potential deviation of actual demand from

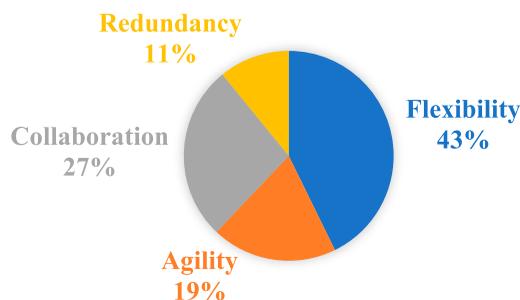


Figure 6. Percent of articles on each of the SCRES enhancers.

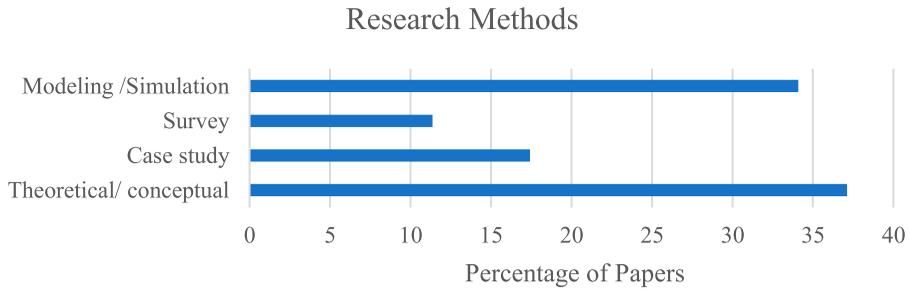


Figure 7. Categorisation of 98 papers based on research method.

forecasted demand or the potential disturbances of the flow of products and information from within the network or between the focal firms and the market (Christopher and Peck 2004; Tang and Tomlin 2008; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). Of the papers that discussed the role of demand risk as a source of disruption risks, 63% mentioned supply chain flexibility as the most effective strategy to cope with demand disruptions, followed by agility, collaboration, and redundancy (Figure 8).

4.2.1 Demand risk: the role of supply chain flexibility

In this study's review of the literature, these are the most frequently mentioned types of supply chain flexibility recommended to mitigate demand disruptions:

- manufacturing flexibility (Chang et al. 2003; Zhang, Vonderembse, and Lim 2003; Ketokivi 2006; Wang, Tai, and Wei 2006; Patel, Terjesen, and Li 2012; Kim, Suresh, and Hillmer 2013; Yu 2013),
- capacity flexibility (Chopra and Sodhi 2004; Bish, Muriel, and Biller 2005; Biller, Muriel, and Zhang 2006; Oke and Gopalakrishnan 2009; Das 2011; Sudarto, Takahashi, and Morikawa 2017),
- operational flexibility (Chod, Rudi, and Mieghem 2010; Moon, Yi, and Ngai 2012; Wang, Thomas, and Rudi 2014; Zhao and Huchzermeier 2017),
- process flexibility (Sánchez and Pérez 2005; Sawhney 2006; Tang and Tomlin 2008; Merschmann and Thonemann 2011),
- product flexibility (Sawhney 2006; Tang and Tomlin 2008; Goyal and Netessine 2011),
- sourcing flexibility (Agarwal, Shankar, and Tiwari 2006; Moon, Yi, and Ngai 2012; Yang, Pan, and Ballot 2017), and
- resourcing flexibility (Bish and Wang 2004; Chod and Rudi 2005; Tomlin and Wang 2005).

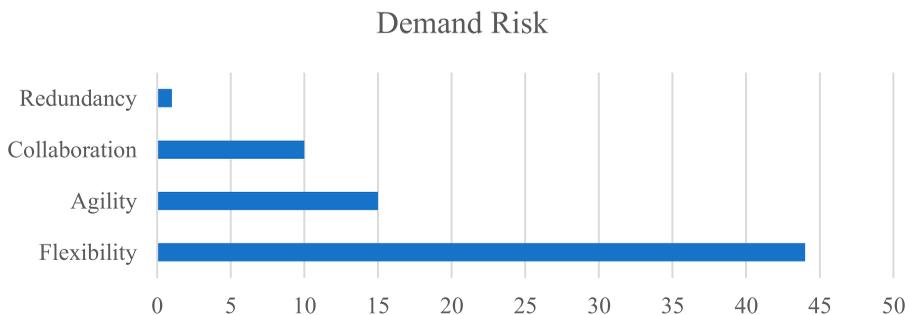


Figure 8. Number of research papers of each type of SCRES enhancer in mitigating demand risk.

In addition, Zhang, Vonderembse, and Lim (2003) showed that there is a strong, positive, direct relationship between flexible manufacturing competence and either volume flexibility or mix flexibility, and also between these two types of flexibility and customer satisfaction. Their findings align with Biller, Muriel, and Zhang (2006), Das (2011), Fernandes, Gouveia, and Pinho (2013), and Moreno and Terwiesch (2015).

4.2.2 Demand risk: the role of supply chain agility

Based on the literature, this study found that the most frequently mentioned dimensions of supply chain agility for managing demand disruption risk are process agility (Ismail and Sharifi 2006; Swafford, Ghosh, and Murthy 2006; Braunscheidel and Suresh 2009; Gligor, Esmark, and Holcomb 2015; Gligor 2016) and supply base agility (Christopher 2000; Lee 2002; Sebastiao and Golicic 2008; Patel, Terjesen, and Li 2012). In addition, a firm can be more agile by emphasizing information sharing, technology development, coordination, and speed (Christopher 2000; Lee 2004; Ismail and Sharifi 2006; Patel, Terjesen, and Li 2012).

4.2.3 Demand risk: the role of supply chain collaboration

By investigating the literature, this study found that the most important dimensions of supply chain collaboration to manage the risk of demand disruptions are a collaborative relationship with customers (Xiaoqiang and Huijiang 2009; Chen, Sohal, and Prajogo 2013; Leat and Giha 2013; Gabler, Richey, and Stewart 2017) and information sharing (Moyaux, Chaib-draa, and D'Amours 2007; Kim and Netessine 2013; Kache and Seuring 2014). Yang and Fan (2016) found that collaborative planning, forecasting, and replenishment for a supply chain is the best frequency response for concurrently managing both operational and disruption risks. In addition, Chen, Sohal, and Prajogo (2013) emphasized collaboration with customers for dealing with demand risk and improving a firm's performance. Their finding aligns with Xiaoqiang and Huijiang (2009), Li and Chan (2012), and Kim, Yamada, and Kim (2008).

4.2.4 Demand risk: the role of supply chain redundancy

This study found Li and Amini (2012) as the only study in the literature that investigated the important role of supply chain redundancy in managing demand disruption risk. They developed an integrated supply chain configuration and new-product diffusion model to show the impact of demand dynamics during a new-product diffusion process on optimal supply chain configuration. Such a multiple-sourcing approach not only helps the firm to diversify its pool of suppliers and maintain bargaining power, it also builds redundancy into the supply chain to hedge against potential demand surge and supply disruption during the new-product life cycle.

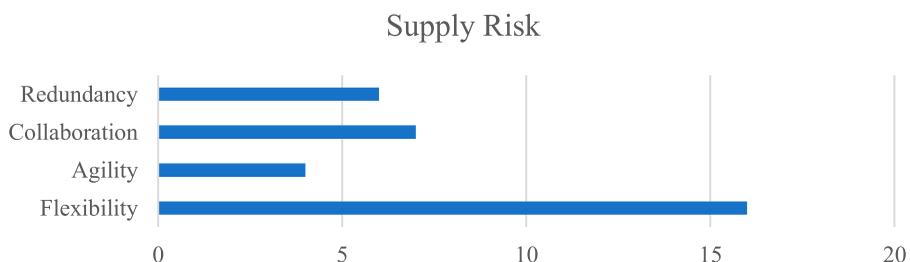


Figure 9. Number of research papers of each type of SCRES enhancer in managing supply risk.

4.3 Supply risk

This study investigated the effect of SCRES antecedents on managing supply risks. This type of risk involves potential deviations in the incoming supplies in terms of time, quality, and quantity or potential disturbances to the flow of products and information from within the network, upstream of the focal firms (Christopher and Peck 2004; Tang and Tomlin 2008; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). Figure 9 shows that 48% of the papers that have discussed the role of supply risk as a source of disruption risks mentioned supply chain flexibility as the most effective strategy to cope with this type of disruption, followed by collaboration, redundancy, and agility.

4.3.1 Supply risk: the role of supply chain flexibility

By reviewing the literature, this study found that these are most important types of supply chain flexibility to manage supply disruption risks:

- supplier flexibility (Tang 2006b; Kouvelis and Li 2008; Tang and Tomlin 2008; Das 2011; Saghafian and Oyen 2016; Sreedevi and Saranga 2017),
- logistics flexibility (Tang 2006b; Yu, Cadeaux, and Song 2013; Jain 2018),
- sourcing flexibility (Moon, Yi, and Ngai 2012; Kamalahmadi and Parast 2016a), and
- process flexibility (Tang and Tomlin 2008; Merschmann and Thonemann 2011).

In addition, Tang (2006b) showed that a flexible supply base performs as a strategy that enables firms to shift production among suppliers promptly, and flexible transportation performs as a strategy that enables firms to change the mode of transportation rapidly. Their findings align with Saghafian and Oyen (2016), Kamalahmadi and Parast (2016a), Jain (2018), Kouvelis and Li (2008), Tang and Tomlin (2008), and Yu, Cadeaux, and Song (2013).

4.3.2 Supply risk: the role of supply chain agility

To investigate the important role of supply chain agility in managing supply risk, Gligor, Esmark, and Holcomb (2015) suggested that the development of a firm's supply chain agility can allow firms to meet customers' ever-changing expectations. Therefore, agility strategies should be embraced in a highly uncertain environment. In addition, Gligor (2016) indicated that agility is a capability that helps to mitigate the negative relationship between aspects of environmental uncertainty and supply chain flexibility. Similarly, Yi, Ngai, and Moon (2011) mentioned agility as one of the four types of flexibility to cope with supply disruption. Sebastiao and Golcic (2008) indicated that a strategy for an agile supply chain requires a firm to have supplier flexibility, be moderately cost competitive, and have a captive source of supply.

4.3.3 Supply risk: the role of supply chain collaboration

Several studies found that a collaborative relationship between buyers and suppliers is the most important dimension of supply chain collaboration in managing supply disruption risk (Faisal, Banwet, and Shankar 2006b; Xiaoqiang and Huijiang 2009; Chen, Sohal, and Prajogo 2013; Tsai 2016). Chen, Sohal, and Prajogo (2013) showed that through supplier collaboration, supply disruption risk can be managed. Also, Tsai (2016) and Xiaoqiang and Huijiang (2009) emphasized that closer cooperation with suppliers is extremely important to manage supply disruption risk. In line with those studies, the literature review by Kache and Seuring (2014) revealed that supply chain collaboration is an effective strategy to reduce demand and supply uncertainty.

4.3.4 Supply risk: the role of supply chain redundancy

This study found that the most important strategies of supply chain redundancy to manage supply disruption risk are multiple suppliers and pre-positioning inventory (Chopra and Sodhi 2004;

Zsidisin and Wagner 2010; Li and Amini 2012; Kamalahmadi and Parast 2017; Namdar et al. 2017). Zsidisin and Wagner (2010) discovered that pursuing SCRES through redundancy moderates the risk perceived from the supply market on disruption occurrence. Besides, Namdar et al. (2017) mentioned some redundancy strategies such as supplier backup, fortification, and protection using emergency inventory to build a resilient supply chain. In line with that, Kamalahmadi and Parast (2017) suggested three redundancy strategies to cope with supply disruption risk: pre-positioning inventory, backup suppliers, and protected suppliers.

4.4 Process risk

Considering process risk as the third source of disruption risk, this study investigated the effect of SCRES antecedents on mitigating process disruptions. Process risk involves potential deviations from producing the desired quality and quantity at the right time. This type of risk includes the quality, time, and capacity risks that are associated with in-bound and out-bound logistics and in-house operations (Christopher and Peck 2004; Tang and Tomlin 2008; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). Figure 10 shows that 80% of the papers that have discussed the role of process risk as a source of disruption risks mentioned supply chain flexibility as the most effective strategy to cope with this type of disruption, followed by collaboration. This review found no studies in the literature that investigated the roles of agility and redundancy in managing the risk of process disruptions.

4.4.1 Process risk: the role of supply chain flexibility

The literature review indicated that these are most frequently mentioned types of supply chain flexibility to manage process disruption risks:

- process flexibility (Sánchez and Pérez 2005; Tang and Tomlin 2008; Merschmann and Thonemann 2011),
- supplier flexibility (Tang and Tomlin 2008; Sreedevi and Saranga 2017),
- capacity flexibility (Chambers, Snir, and Ata 2009; Das and Lashkari 2015), and
- sourcing flexibility (Moon, Yi, and Ngai 2012; Demirel, Kapuscinski, and Yu 2017).

Merschmann and Thonemann (2011) indicated that companies that match supply chain flexibility and uncertainty realise higher performance than companies that do not achieve such a match. Similarly, Sreedevi and Saranga (2017) showed that firms that match their supply and manufacturing flexibility with uncertainty have lower supply and process risk. Moreover, Sánchez and Pérez (2005) showed that flexibility capabilities are enhanced in supply chains with higher environmental uncertainty, more technological complexity, and greater mutual understanding.

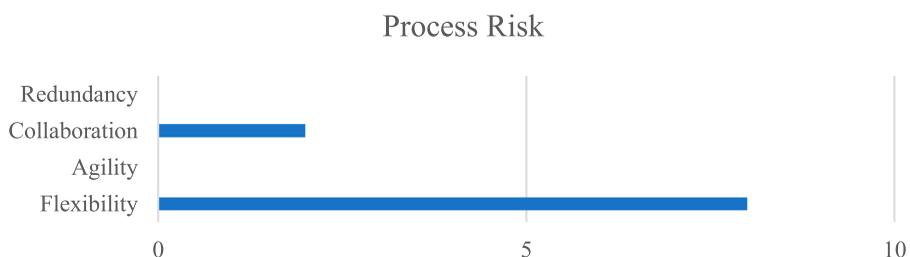


Figure 10. Number of research papers of each type of SCRES enhancer in managing process risk.

4.4.2 Process risk: the role of supply chain collaboration

There are two studies that examined the important role of supply chain collaboration in managing process risk. Chen, Sohal, and Prajogo (2013) showed that while process disruptions have the most severe direct effect on supply chain performance, their risk can be managed through internal collaboration. Gunasekaran, Subramanian, and Rahman (2015) indicated that collaboration ensures the exchange of information between supply chain partners and reduces uncertainties and complexity. They showed that the exchange of information in all activities in a process, along with necessary relationships, will certainly help a supply chain to reduce uncertainty. Therefore, collaboration during product design and supply chain design will reduce the complexity and uncertainty in a supply chain.

4.5. Control risk

Considering control risk as the fourth source of risks, this study investigated the effect of SCRES antecedents in managing control risks. Control or network risks are the assumptions, rules, systems, and procedures that govern how an organisation exerts control over processes. These kinds of risks can also occur when a supplier is vertically integrated and a direct competitor of the customer firm forces the termination of the relationship (Chopra and Sodhi 2004; Christopher and Peck 2004; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). Figure 11 shows that 86% of the papers that discussed the role of control risk as a source of disruption risks mentioned supply chain collaboration as the most effective strategy to cope with this type of disruption, followed by flexibility. In addition, no studies have been conducted to investigate the roles of agility and redundancy in managing control risk.

4.5.1 Control risk: the role of supply chain flexibility

Based on the literature, Kesen, Kanchanapiboon, and Das (2010) is the only study that noted flexible supply contracts as an important strategy to cope with control uncertainty. They indicated that supply contract models can be used to evaluate multiple supply proposals, each with a different quantity minimum and penalty rate, which can lead to eliminating non-competitive suppliers and initiate contract negotiations with the others.

4.5.2 Control risk: the role of supply chain collaboration

The literature review found that the most important dimensions of supply chain collaboration in managing control disruption risk are collaborative communication (Faisal, Banwet, and Shankar 2006b; Cao et al. 2010; Revilla and Saenz 2017; Zeng and Yen 2017), information sharing (Faisal, Banwet, and Shankar 2006b; Cao et al. 2010; Gunasekaran, Subramanian, and Rahman 2015), and trust (Faisal, Banwet, and Shankar 2006b; Li et al. 2015). Cao et al. (2010) conceptualised supply chain collaboration as seven interconnected elements: information sharing, goal congruence, decision synchronisation, incentive alignment, resource sharing, collaborative communication, and joint knowledge creation. The authors indicated that the benefits of supply chain collaboration



Figure 11. Number of research papers of each type of SCRES enhancer in managing control risk.

may be realised when there is cooperation among all parties in a supply chain, from suppliers to customers. In addition, Zeng and Yen (2017) showed that the level of collaboration among partners contributes to the resilience of a supply chain. They indicated that partnerships can positively affect the integration of supply chain risk systems, thus benefiting operations in supply chains.

4.6 Environmental risk

For the fifth and last source of supply chain disruption risk, this study investigated the effect of SCRES antecedents in managing environmental risks. These risks are external to the supply chain network. They may affect a particular value stream or any node or link through which the supply chain passes (Christopher and Peck 2004; Tang and Tomlin 2008; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). Figure 12 shows that 61% of the papers that discussed the role of environmental risk mentioned supply chain flexibility as the most effective strategy to cope with this type of disruption, followed by agility, collaboration, and redundancy.

4.6.1 Environmental risk: the role of supply chain flexibility

By reviewing the literature, this study found that these are most frequently mentioned types of supply chain flexibility to manage environmental disruption risks:

- logistics flexibility (Tang 2006b; Yu, Cadeaux, and Song 2013; Fan, Schwartz, and Voß 2017),
- operational flexibility (Sheffi and Rice 2005; Olson 2010),
- sourcing flexibility (Kamalahmadi and Parast 2016a; Yang, Pan, and Ballot 2017),
- capacity flexibility (Oke and Gopalakrishnan 2009; Das and Lashkari 2015),
- manufacturing flexibility (Llorens, Molina, and Verdu 2005; Patel, Terjesen, and Li 2012), and
- strategic flexibility (Engau, Hoffmann, and Busch 2011; Huang, Yen, and Liu 2014).

Huang, Yen, and Liu (2014) indicated that in a situation of high technological uncertainty, firms can adopt ambidextrous interorganizational forms to gain a competitive advantage by simultaneously managing both short-term operational efficiency and long-term strategic flexibility. Similarly, Patel, Terjesen, and Li (2012) indicated that firms that are better able to acquire, assimilate, and transform information are more likely to respond to environmental uncertainty with manufacturing flexibility. In addition, ambidexterity enhances the likelihood that firms operating in uncertain environments will respond with flexible strategies (Huang, Yen, and Liu 2014).

4.6.2 Environmental risk: the role of supply chain agility

This study revealed that the important dimensions of supply chain agility to cope with environmental risk are mobility of resources (Kleindorfer and Saad 2005), capacity agility (Lücker and Seifert 2017), and workforce agility (Qin and Nembhard 2010). Lücker and Seifert (2017) analyzed three risk mitigation levers in their research: holding additional inventory (disruption mitigation inventory), dual sourcing, and keeping reserved capacity (agility capacity agility). They showed that as

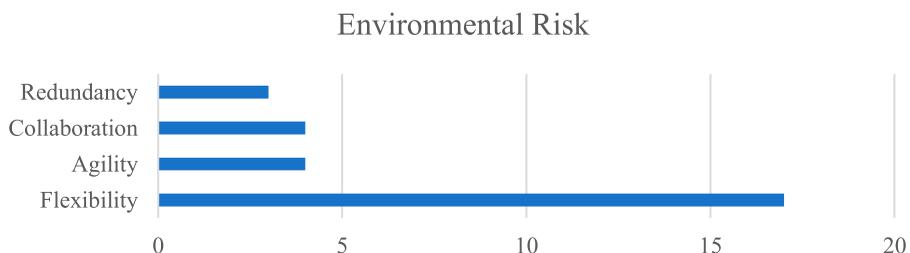


Figure 12. Number of research papers of each type of SCRES enhancer in managing environmental risk.

long as no dual sourcing is available, disruption mitigation inventory and agility capacity can be substitutes for each other. When dual sourcing is available, agility capacity and dual sourcing appear to be substitutes for each other. In addition, Yang, Pan, and Ballot (2017) illustrated that the physical internet inventory model, with greater agility and flexibility, outperforms the current inventory models in terms of resilience.

4.6.3 Environmental risk: the role of supply chain collaboration

To investigate the important role of supply chain collaboration in managing environmental risk, Kleindorfer and Saad (2005) asserted that trust, information sharing, and continuity of profitability are the basic glue that makes supply chain partnerships a reality. Continuous coordination, cooperation, and collaboration among supply chain partners are needed for risk avoidance, risk reduction, and disruption mitigation, so that the value and benefits generated are maximised and shared fairly (Kim, Yamada, and Kim 2008). In addition, Dubey et al. (2017) showed that trust, cooperation among supply chain partners, and supply chain visibility may help to build a resilient supply chain. They concluded that managers need to focus on collaborative relationships instead of cultivating competition and opportunism.

4.6.4 Environmental risk: the role of supply chain redundancy

Kamalahmadi and Parast (2017) showed how adding redundancy to a supply chain in different forms, along with contingency plans, can help firms mitigate the impact of supply chain disruptions. Furthermore, they indicated that regionalising a supply chain is an effective way to mitigate the negative impact of environmental disruptions on a supply chain. Their findings align with Kleindorfer and Saad (2005), who indicated that providing an appropriate backup system to make a redundant supply chain can increase the robustness of the supply chain. Sheffi and Rice (2005) indicated that the most common forms of supply chain redundancy are safety stock, multiple suppliers, and low capacity utilisation rate.

5. Discussion: findings and implications

This study examined three questions in the context of SCRES and SCRM:

- (1) What is the current state of research in SCRES and the management of supply chain disruption risks?
- (2) Regarding the various sources of disruption risk in supply chains (supply risk, demand risk, environment risk, process risk, and control risk), in what SCRES enhancers should a firm invest as the best strategy to build a resilient supply chain?
- (3) What are the gaps in current research that future research should address?

For this purpose, this study employed an SLR to study the literature of SCRES and SCRM. This study is believed to be the first literature review in the field of SCRES specifically focused on mitigating supply chain disruptions by investing in some antecedents of SCRES. Employing the SLR methodology in finding high-quality publications based on the Association of Business Schools rating resulted in 98 publications. After the summary of findings presented below, future research directions on SCRES are discussed.

5.1. Supply chain disruption risks

For this study, a framework was first proposed for clarifying the definitions for various kinds of supply chain disruption risks (Figure 1). Based on the proposed framework and definitions of five sources of risk in a supply chain, this study discussed the most important strategies of SCRES to cope with each of these sources of disruption risk. The results showed that while supply chain

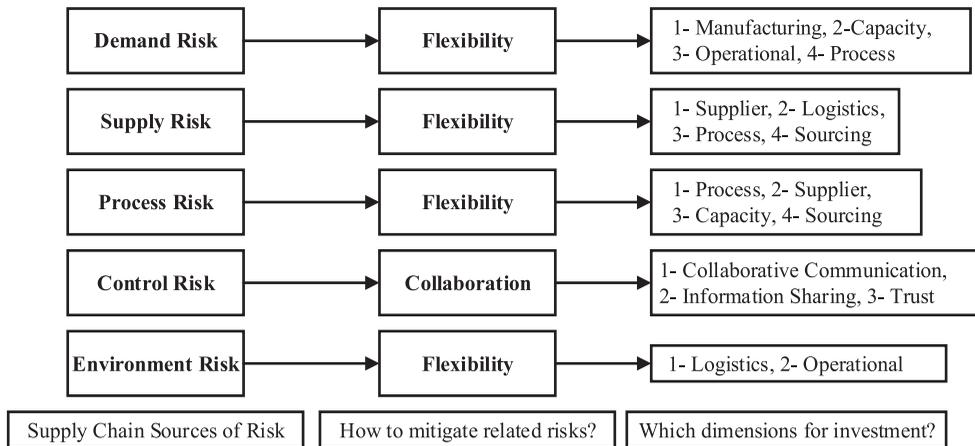


Figure 13. SCRES strategies and their dimensions to mitigate each type of supply chain disruption.

flexibility has been identified frequently in the literature as the most important strategy to cope with demand, supply, process, and environmental risk, supply chain collaboration has been identified in the literature as the most important strategy to cope with control risk (Figure 13). Moreover, the findings showed the following:

- For mitigating demand disruptions, manufacturing flexibility is the most important dimension of supply chain flexibility.
- For mitigating supply disruptions, supplier flexibility is the most important dimension of supply chain flexibility.
- For mitigating process disruptions, process flexibility is the most important dimension of supply chain flexibility.
- For mitigating environmental disruptions, logistics flexibility and operational flexibility are the most important dimensions of supply chain flexibility.
- For mitigating control disruptions, collaborative communication, information sharing, and trust are the most important dimensions of supply chain collaboration.

5.2. SCRES enhancers

5.2.1 Flexibility

This literature review found that 43% of the studies emphasized the important role of supply chain flexibility in enhancing SCRES (Figure 6). In addition, this research showed that studies emphasized the important role of supply chain flexibility in managing different sources of disruption risk: 48% of the studies emphasized demand risk, 21% emphasized environment risk, 20% emphasized supply risk, 10% emphasized process risk, and 1% emphasized control risk. As indicated in Figure 13, this study found manufacturing, capacity, operational, and process flexibility as the most effective dimensions of supply chain flexibility to cope with demand disruption risks; supplier, logistics, process, and sourcing flexibility to cope with supply disruption risks; process, supplier, capacity, and sourcing flexibility to cope with process disruption risks; and logistics and operational flexibility to cope with environmental disruption risks.

A conceptual study by Merschmann and Thonemann (2011) showed that the companies in their study that matched supply chain flexibility (including internal flexibility and customer-oriented flexibility) and environmental uncertainty achieved a performance of 4.1 on a 5-point scale, while companies with a mismatch only achieved a performance of 3.1. In addition, Sánchez and Pérez

(2005) showed that, on a seven-point Likert scale, delivery flexibility is the most important dimension of flexibility that is related to supply chain performance, followed by volume flexibility, routing flexibility, flexibility in response to market, product flexibility, access flexibility, transshipment flexibility, postponement flexibility, launch flexibility, and sourcing flexibility.

One direction for future research is to examine the relative importance of different types of supply chain flexibility on improving a firm's resilience to supply chain disruptions (Parast and Shekarian 2019). For example, Stevenson and Spring (2007) identified 21 dimensions of supply chain flexibility not yet discussed in the literature, such as material handling, automation, routing, programme output, new design, expansion, market, robustness, reconfiguration, and inter-organizational flexibility. Using the proposed framework (Figure 1), one avenue for future research is to examine the effect of other types of flexibility on mitigating different types of supply chain disruptions (demand, supply, environmental, control, and process). In addition, few studies have been conducted to investigate the impact of supply chain flexibility on managing control disruption risk; this can be addressed in future research.

5.2.2 Agility

As shown in Figure 6, this study found that 19% of the studies discussed the important role of supply chain agility in enhancing SCRES. Moreover, this research showed that studies emphasized the important role of supply chain agility in managing three sources of disruption risk: 65% of the studies emphasized demand risk, 17% emphasized supply risk, and 17% emphasized environment risk. In addition, this study found that process and supply base agility are the most effective dimensions of supply chain agility to cope with demand disruption risks, and mobility of resources, capacity, and workforce agility are the most effective dimensions of supply chain agility to cope with environmental disruption risks. According to Agarwal, Shankar, and Tiwari (2006), the values for a supply chain performance-weighted index relationship are 0.343 for leagile, 0.340 for agile, and 0.316 for lean supply chain, which emphasizes the important role of supply chain agility on firm performance.

The literature reviewed for this study lacked studies identifying the dimensions of agility to cope with supply disruption risks. In addition, there was no study in the literature emphasizing the role of supply chain agility in managing control or process disruption risks; this can be considered in future research.

5.2.3 Collaboration

This study found that 27% of the literature emphasized the important role of supply chain collaboration in enhancing SCRES (Figure 6). Moreover, this research showed that studies emphasized the important role of supply chain collaboration in managing different sources of disruption risk: 34% of the studies emphasized demand risk, 24% emphasized supply risk, 21% emphasized control risk, 14% emphasized environment risk, and 7% emphasized process risk. In addition, this study found that collaborative relationships with customers or suppliers and information sharing are the most effective dimensions of supply chain collaboration to cope with demand disruption risks; collaborative relationships with the customers or suppliers to cope with supply disruption risks; collaborative communication, information sharing, and trust to cope with control disruption risks; information sharing with partners to cope with process disruption risks; and continuous coordination and cooperation to cope with environmental disruption risks.

Cao et al. (2010) showed that supply chain collaboration is significantly related to firm performance. They indicated that joint knowledge creation is the most important factor to create a collaborative supply chain, followed by collaborative communication, goal congruence, resource sharing, information sharing, incentive alignment, and decision synchronisation. Chen, Sohal, and Prajogo (2013) found that among supply, demand, and process risk, process risk has the most severe direct effect on supply chain performance, an effect that can be mitigated through internal collaboration. A literature review by Kache and Seuring (2014) identified information sharing as the most important

dimension of supply chain collaboration to improve supply chain performance, followed by reward sharing. Finally, Li et al. (2015) found that risk-information sharing and risk-sharing mechanisms improve financial performance.

This literature review found only a few studies showing the impact of supply chain collaboration in managing process and environmental disruption risks; this can be addressed by future research.

5.2.4 Redundancy

As shown in Figure 6, this study found that 11% of the studies discussed the important role of supply chain redundancy in enhancing SCRES. In addition, this research showed that studies emphasized the important role of supply chain redundancy in managing three sources of disruption risk: 60% of the studies emphasized supply risk, 30% emphasized environmental risk, and 10% emphasized demand risk. In addition, this study found multiple suppliers and pre-positioning inventory as the most effective dimensions of supply chain redundancy to cope with supply disruption risks, and regionalising and multiple suppliers as the most effective dimensions of supply chain redundancy to cope with environmental disruption risks.

This literature review found only one study that investigated the role of supply chain redundancy in coping with demand disruption risk (Li and Amini 2012). There were no studies in the literature that emphasized the role of supply chain redundancy in managing control and process disruption risks; this can be considered for future research.

5.3 Implications for theory and practice

The first contribution of this paper is to provide a clear definition for each source of disruption risk (i.e. demand, supply, process, control, and environmental) and to propose a categorisation based on these definitions, in order to distinguish different sources of disruption risk. The definitions and categorisation were used to relate organisational capabilities to different types of supply chain disruption risk (Christopher and Peck 2004; Tang and Tomlin 2008; Leat and Giha 2013; Samvedi, Jain, and Chan 2013). By proposing Figure 1, this paper aims to provide a better understanding of the relationship between various sources of disruption risk and the organisational capabilities (i.e. resilience enhancers) that mitigate the negative impact of supply chain disruptions on organisational performance. Such a relationship has not previously been discussed in the literature. These findings have important implications for the theory and practice of supply chain risk management because the findings identify the types of organisational capabilities that need to be developed in order for a firm to respond to different types of disruptions.

In addition, the main research contribution of this study is the analysis of the SCRES antecedents on mitigating disruptions; the analysis incorporated an SLR methodology (Figure 2) to develop a concept-mapping framework. The evaluation and synthesis of the current body of literature have enhanced the understanding of SCRES and supply chain disruption risks in several ways. First, the SLR synthesis addressed the question of which dimensions of SCR enhancers would provide the most improvement in organisational performance when faced with various sources of disruption risks (demand, supply, process, control, and environment). The findings do several things: they provide a more nuanced understanding of the relationship between different types of supply chain resilience enhancers (flexibility, agility, collaboration, and redundancy) and different types of supply chain disruption; they provide further insights for decision makers regarding the relative importance of different types of supply chain resilience enhancers for mitigating supply chain disruptions; and they suggest that firms that are more exposed to supply chain disruptions should invest in different types of organisational capabilities from firms that are more exposed to demand disruptions. By investigating the role of supply chain flexibility, agility, collaboration, and redundancy in mitigating disruptions, and scrutinising their definitions, dimensions, and impacts on building a resilient supply chain, this study provided a better understanding of the specific roles of these antecedents in a supply

chain network, which leads to better use of them by managers when a supply chain is exposed to disruption risks.

Furthermore, this paper developed a framework (Figure 13) that highlights the important role of antecedents of SCRES in managing each source of disruption risks. The proposed framework will assist scholars and practitioners first in identifying sources of disruption risk within their supply chain, and second in employing effective SCRES enhancer strategies to cope with those disruption risks. Furthermore, the clear definitions and distinctions of the supply chain disruption risks and their different sources (Figure 1) will help practitioners better understand the factors influencing SCRES.

6. Limitations and recommendations for future research

The findings and implications presented by this study have limitations. First, while this study considered the impact of four important antecedents of SCRES, considering the role of other antecedents of SCRES such as visibility, integration, structure and knowledge, and reengineering can be investigated in future research (Christopher and Peck 2004; Ponomarov and Holcomb 2009; Kamalahmadi and Parast 2016b). Second, other categorizations of supply chain risks (e.g. Peck 2004; Tang 2006a; Simangunsong, Hendry, and Stevenson 2012; Sodhi, Son, and Tang 2012; Ho et al. 2015) can be considered for investigation in future research. Considering these limitations, further research is addressed in the next sections.

6.1 Theorising and conceptualising supply chain disruption

This research noticed that most of the studies have not explicitly referred to each type of supply chain disruption when they examine the effect of resilience enhancers in managing supply chain disruption risks, such as Scholten and Schilder (2015), Wu, Blackhurst, and O'grady (2007), Stevenson and Spring (2007), and Hendricks and Singhal (2005). Therefore, it would be difficult to assess the actual impact of resilience enhancers on each type of disruption risk. Identifying the effect of each type of resilience enhancer on each type of supply chain disruption risk can provide significant managerial insights into selecting the best resilience enhancers when a firm is faced with each type of disruption risk.

6.2 Understanding the different dimensions of resilience enhancers

This study found that understanding the different dimensions of SCRES enhancers is of crucial importance for managers to cope with each type of supply chain disruption risk. This research identified manufacturing flexibility, process agility, and collaborative relationships as the important dimensions of each type of SCRES enhancers to cope with demand disruption risks; supplier flexibility, multiple sourcing, and collaborative relationships to cope with supply disruption risks; process flexibility to cope with process disruption risks; collaborative communication to cope with control disruption risks; and operational and logistics flexibility to cope with environmental disruption risks. This research found that only a few studies have investigated the important role of various dimensions of supply chain agility and redundancy in coping with either demand or environmental disruption risks. No studies have been conducted to investigate the important roles of supply chain agility and redundancy in coping with either process or control disruption risks. Without understanding these relationships, it would be difficult to identify the best SCRES strategy to cope with various kinds of disruption risks. Addressing these issues can be an avenue for future research.

6.3 A supply chain approach to resilience

This study found that 70% of the papers investigated the impact of demand disruption risks on SCRES, followed by 33% for supply disruption risks, 28% for environmental disruption risks, 10%

for process disruption risks, and 7% for control disruption risks. While most of the studies have been focused on investigating the impact of demand disruption risks on SCRES, there has been less attention to investigate the impact of process and control disruption risks. In addition, while a number of studies such as Yang, Pan, and Ballot (2017), Kamalahmadi and Parast (2016a), Patel, Terjesen, and Li (2012), and Das (2011) have investigated the simultaneous effect of two or three different kinds of supply chain disruption risks on SCRES, to the best of our knowledge, there have been no studies to investigate the simultaneous impact of all of these types of disruption risks on SCRES. Further investigation is proposed to find these relationships.

6.4 Research design

According to Figure 7, 37% of the research methodology of the reviewed papers was theoretical/conceptual, followed by 34% modelling/simulation, 17% case study, and 12% survey. The analysis suggests that existing studies are mainly based on the use of theoretical or conceptual models. This space could be further expanded and enriched to include case studies, surveys, experiments, and simulations.

7. Conclusions

In this research study, several research questions in SCRM and SCRES were addressed. First, this study investigated the current state of SCRES in the literature. It started by clarifying the definitions of various types of disruption risks (Figure 1), then this study identified some important strategies of SCRES enhancers that help manage supply chain disruption risks. In addition, this study showed that the appropriate selection of SCRES enhancers (flexibility, agility, collaboration, and redundancy) is of great importance for firms when faced with different types of disruption risks (demand, supply, process, control, and environmental risk).

The literature review presented here is different from previous studies in terms of its aim, scope, approach, methodology, and contribution. The research for this paper was performed via an SLR of 98 peer-reviewed publications and journal papers published within an 18-year time frame (2000–2017). After conducting a comprehensive SLR on SCRES, the findings showed that while flexibility has been identified by the literature as the most important strategy to cope with demand, supply, process, and environmental disruption risks, collaboration has been indicated several times in the literature as the most important strategy to cope with control disruption risks. This study then proposed an SCRES timeline and framework for identifying the most important strategy of SCRES in coping with each type of supply chain disruption risk (Figure 13). By understanding the current gaps, this research then proposed some suggestions in terms of theorising of supply chain disruptions, understanding the different dimensions of SCRES, supply chain approaches to resilience, and research designs for future studies.

Note

1. To effectively search and find these terms in the databases, the closest root to the original terms (words) was used. For example: “flexib*” searches for any word that starts with “flexib” (Ali, Mahfouz, and Arisha 2017).

Acknowledgments

This research is based upon work supported by the National Science Foundation (NSF) under grant numbers 1238878 and 1533681. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by National Science Foundation.

References

- Agarwal, A., R. Shankar, and M. K. Tiwari. 2006. "Modeling the Metrics of Lean, Agile and Leagile Supply Chain: An ANP-Based Approach." *European Journal of Operational Research* 173: 211–225.
- AJG (Academic Journal Guideline). 2015. <https://charteredabs.org/academic-journal-guide-2015-view/>.
- Ali, A., A. Mahfouz, and A. Arisha. 2017. "Analysing Supply Chain Resilience: Integrating the Constructs in a Concept Mapping Framework via a Systematic Literature Review." *Supply Chain Management: An International Journal* 22 (1): 16–39.
- Aqlan, F., and S. S. Lam. 2015. "Supply Chain Risk Modelling and Mitigation." *International Journal of Production Research* 53 (18): 5640–5656.
- Ates, A., and U. Bititci. 2011. "Change Process: A key Enabler for Building Resilient SMEs." *International Journal of Production Research* 49 (18): 5601–5618.
- Behzadi, G., M. J. O'Sullivan, T. L. Olsen, and A. Zhang. 2018. "Allocation Flexibility for Agribusiness Supply Chains Under Market Demand Disruption." *International Journal of Production Research* 56 (10): 3524–3546.
- Beske, P., and S. Seuring. 2014. "Putting Sustainability Into Supply Chain Management." *Supply Chain Management: An International Journal* 19 (3): 322–331.
- Billar, S., A. Muriel, and Y. Zhang. 2006. "Impact of Price Postponement on Capacity and Flexibility Investment Decisions." *Production and Operations Management* 15 (2): 198–214.
- Bish, E. K., A. Muriel, and S. Billar. 2005. "Managing Flexible Capacity in a Make-to-Order Environment." *Management Science* 51 (2): 167–180.
- Bish, E. K., and Q. Wang. 2004. "Optimal Investment Strategies for Flexible Resources, Considering Pricing and Correlated Demands." *Operations Research* 2 (6): 954–964.
- Blome, C., T. Schoenherr, and D. Eckstein. 2014. "The Impact of Knowledge Transfer and Complexity on Supply Chain Flexibility: A Knowledge- Based View." *International Journal of Production Economics* 147: 307–316.
- Booth, A., M. Clarke, G. Dooley, D. Ghersi, D. Moher, M. Petticrew, and L. Stewart. 2012. "The Nuts and Bolts of PROSPERO: An International Prospective Register of Systematic Reviews." *Systematic Reviews* 1 (1): 2.
- Borekci, D. Y., Y. Rofcanin, and H. Gürbüz. 2015. "Organisational Resilience and Relational Dynamics in Triadic Networks: A Multiple Case Analysis." *International Journal of Production Research* 53 (22): 6839–6867.
- Braunscheidel, M. J., and N. C. Suresh. 2009. "The Organizational Antecedents of a Firm's Supply Chain Agility for Risk Mitigation and Response." *Journal of Operations Management* 27: 119–140.
- Burgess, K., P. J. Singh, and R. Koroglu. 2006. "Supply Chain Management: a Structured Literature Review and Implications for Future Research." *International Journal of Operations & Production Management* 26 (7): 703–729.
- Butner, K. 2010. "The Smarter Supply Chain of the Future." *Strategy & Leadership* 38 (1): 22–31.
- Cao, M., M. A. Vonderembse, Q. Zhang, and T. S. Ragu-Nathan. 2010. "Supply Chain Collaboration: Conceptualisation and Instrument Development." *International Journal of Production Research* 48 (22): 6613–6635.
- Carter, C. R., and D. S. Rogers. 2008. "A Framework of Sustainable Supply Chain Management: Moving Toward new Theory." *International Journal of Physical Distribution and Logistics Management* 38 (5): 360–387.
- Chambers, C. G., E. M. Snir, and A. Ata. 2009. "The use of Flexible Manufacturing Capacity in Pharmaceutical Product Introductions." *Decision Science* 40 (2): 243–268.
- Chan, A. T., E. W. Ngai, and K. K. Moon. 2017. "The Effects of Strategic and Manufacturing Flexibilities and Supply Chain Agility on Firm Performance in the Fashion Industry." *European Journal of Operational Research* 259 (2): 486–499.
- Chang, S. C., C. L. Yang, H. C. Cheng, and C. Sheu. 2003. "Manufacturing Flexibility and Business Strategy: An Empirical Study of Small and Medium Sized Firms." *International Journal of Production Economics* 83: 13–26.
- Chen, J., A. S. Sohal, and D. L. Prajogo. 2013. "Supply Chain Operational Risk Mitigation: A Collaborative Approach." *International Journal of Production Research* 51 (7): 2186–2199.
- Chod, J., and N. Rudi. 2005. "Resource Flexibility with Responsive Pricing." *Operations Research* 53 (3): 532–548.
- Chod, J., N. Rudi, and J. A. Mieghem. 2010. "Operational Flexibility and Financial Hedging: Complements or Substitutes?" *Management Science* 56 (6): 1030–1045.
- Chopra, S., and M. S. Sodhi. 2004. "Managing Risk to Avoid Supply Chain Breakdown." *MIT Sloan Management Review* 46 (1): 53–61.

- Christopher, M. 2000. "The Agile Supply Chain Competing in Volatile Markets." *Industrial Marketing Management* 29: 37–44.
- Christopher, M., and M. Holweg. 2011. "Managing Supply Chains in the era of Turbulence." *International Journal of Physical Distribution & Logistics Management* 41 (1): 63–82.
- Christopher, M., and H. Peck. 2004. "Building the Resilient Supply Chain." *International Journal of Logistics Management* 15 (2): 1–13.
- Colicchia, C., F. Dallaria, and M. Melacini. 2011. "A Simulation-Based Framework to Evaluate Strategies for Managing Global Inbound Supply Risk." *International Journal of Logistics: Research and Applications* 14 (6): 371–384.
- Colicchia, C., and F. Strozzi. 2012. "Supply Chain Risk Management: A new Methodology for a Systematic Literature Review." *Supply Chain Management: An International Journal* 17 (4): 403–418.
- Craighead, C. W., J. Blackhurst, M. J. Rungtusanatham, and R. B. Handfield. 2007. "The Severity of Supply Chain Disruptions: Design Characteristics and Mitigation Capabilities." *Decision Sciences* 38 (1): 131–156.
- Das, K. 2011. "Integrating Effective Flexibility Measures Into a Strategic Supply Chain." *European Journal of Operational Research* 211: 170–118.
- Das, K., and R. S. Lashkari. 2015. "Risk Readiness and Resiliency Planning for a Supply Chain." *International Journal of Production Research* 53 (22): 6752–6771.
- Demirel, S., R. Kapuscinski, and M. Yu. 2017. "Strategic Behavior of Suppliers in the Face of Production Disruptions." *Management Science* 64 (2): 533–551.
- Denyer, D., and D. Tranfield. 2009. "Producing a Systematic Review." In *The Sage Handbook of Organizational Research Methods*, edited by D. A. Buchanan and A. Bryman, 671–689. Thousand Oaks, CA: Sage.
- Dominik, E., G. Matthias, B. Constantin, and L. Michael. 2015. "The Performance Impact of Supply Chain Agility and Supply Chain Adaptability: The Moderating Effect of Product Complexity." *International Journal of Production Research* 53 (10): 2–44.
- Dubey, R., A. Gunasekaran, S. J. Childe, T. Papadopoulos, C. Blome, and Z. Luo. 2017. "Antecedents of Resilient Supply Chains: An Empirical Study." *IEEE Transactions on Engineering Management* 99: 1–12.
- Durach, C. F., A. Wieland, and J. A. Machuca. 2015. "Antecedents and Dimensions of Supply Chain Robustness: a Systematic Literature Review." *International Journal of Physical Distribution & Logistics Management* 45 (1/2): 118–137.
- Engau, C., V. H. Hoffmann, and T. Busch. 2011. "Airlines' Flexibility in Facing Regulatory Uncertainty: To Anticipate or Adapt?" *California Management Review* 54 (1): 107–125.
- Faisal, M. N., D. K. Banwet, and R. Shankar. 2006a. "Mapping Supply Chains on Risk and Customer Sensitivity Dimensions." *Industrial Management & Data Systems* 106 (6): 878–895.
- Faisal, M. N., D. K. Banwet, and R. Shankar. 2006b. "Supply Chain Risk Mitigation: Modeling the Enablers." *Business Process Management Journal* 12 (4): 535–552.
- Fan, Y., F. Schwartz, and S. Voß. 2017. "Flexible Supply Chain Planning Based on Variable Transportation Modes." *International Journal of Production Economics* 183: 654–666.
- Fang, H., C. Li, and R. Xiao. 2012. "Supply Chain Network Design Based on Brand Differentiation and Resilient Management." *Journal of Information & Computational Science* 9 (14): 3977–3986.
- Fernandes, R., B. Gouveia, and C. Pinho. 2013. "Integrated Inventory Valuation in Multi-Echelon Production/Distribution Systems." *International Journal of Production Research* 51 (9): 2578–2592.
- Gabler, C. B., R. G. Richey, and G. T. Stewart. 2017. "Disaster Resilience Through Public–Private Short-Term Collaboration." *Journal of Business Logistics* 38 (2): 130–144.
- Ghadge, A., S. Dani, and R. Kalawsky. 2012. "Supply Chain Risk Management: Present and Future Scope." *International Journal of Logistics Management* 23 (3): 313–339.
- Gligor, D. M. 2016. "The Role of Supply Chain Agility in Achieving Supply Chain fit." *Decision Sciences* 47 (3): 524–553.
- Gligor, D. M., C. L. Esmark, and M. C. Holcomb. 2015. "Performance Outcomes of Supply Chain Agility: When Should you be Agile?" *Journal of Operations Management* 33 (34): 71–82.
- Gold, S., S. Seuring, and P. Beske. 2010. "The Constructs of Sustainable Supply Chain Management: A Content Analysis Based on Published Case Studies." *Progress in Industrial Ecology: An International Journal* 7 (2): 114–137.
- Goyal, M., and S. Netessine. 2011. "Volume Flexibility, Product Flexibility, or Both: The Role of Demand Correlation and Product Substitution." *Manufacturing & Service Operations Management* 13 (2): 180–193.
- Gunasekaran, A., N. Subramanian, and S. Rahman. 2015. "Supply Chain Resilience: Role of Complexities and Strategies." *International Journal of Production Research* 53 (22): 6809–6819.
- Gurning, S., and S. Cahoon. 2011. "Analysis of Multi-Mitigation Scenarios on Maritime Disruptions." *Maritime Policy & Management* 38 (3): 251–268.
- Heckmann, I., T. Comes, and S. Nickel. 2015. "A Critical Review on Supply Chain Risk Definition, Measure and Modeling." *Omega* 52: 119–132.
- Hendricks, K., and V. Singhal. 2005. "An Empirical Analysis of the Effect of Supply Chain Disruptions on Long-run Stock Price Performance and Equity Risk of the Firm." *Production and Operations Management* 14 (1): 25–53.

- Ho, W., T. Zheng, H. Yildiz, and S. Ta. 2015. "Supply Chain Risk Management: a Literature Review." *International Journal of Production Research* 53 (16): 5031–5069.
- Hohenstein, N. O., E. Feisel, E. Hartmann, and L. Giunipero. 2015. "Research on the Phenomenon of Supply Chain Resilience: A Systematic Review and Paths for Further Investigation." *International Journal of Physical Distribution & Logistics Management* 45 (1/2): 90–117.
- Huang, M. C., G. F. Yen, and T. C. Liu. 2014. "Reexamining Supply Chain Integration and the Supplier's Performance Relationships Under Uncertainty." *Supply Chain Management: An International Journal* 19 (1): 64–78.
- Ismail, H. S., and H. Sharifi. 2006. "A Balanced Approach to Building Agile Supply Chains." *International Journal of Physical Distribution & Logistics Management* 36 (6): 431–444.
- Ivanov, D. 2018. "Revealing Interfaces of Supply Chain Resilience and Sustainability: A Simulation Study." *International Journal of Production Research* 56 (10): 3507–3523.
- Ivanov, D., A. Dolgui, B. Sokolov, and M. Ivanova. 2017. "Literature Review on Disruption Recovery in the Supply Chain." *International Journal of Production Research* 55 (2): 6158–6174.
- Ivanov, D., B. Sokolov, and A. Dolgui. 2014. "The Ripple Effect in Supply Chains: Trade-off 'Efficiency-Flexibility-Resilience' in Disruption Management." *International Journal of Production Research* 52 (7): 2154–2172.
- Jain, A. 2018. "Responding to Shipment Delays: The Roles of Operational Flexibility and Lead-Time Visibility." *Decision Sciences* 49 (2): 306–334.
- Jain, V., S. Kumar, U. Soni, and C. Chand. 2017. "Supply Chain Resilience: Model Development and Empirical Analysis." *International Journal of Production Research* 55 (22): 6779–6800.
- Jüttner, U., and S. Maklan. 2011. "Supply Chain Resilience in the Global Financial Crisis: An Empirical Study." *Supply Chain Management: An International Journal* 16 (4): 246–259.
- Kache, F., and S. Seuring. 2014. "Linking Collaboration and Integration to Risk and Performance in Supply Chains via a Review of Literature." *Supply Chain Management: An International Journal* 19 (5/6): 664–682.
- Kamalahmadi, M., and M. Parast. 2016a. "Developing a Resilient Supply Chain Through Supplier Flexibility and Reliability Assessment." *Intronational Journal of Production Research* 54: 302–321.
- Kamalahmadi, M., and M. Parast. 2016b. "A Review of the Literature on the Principles of Enterprise and Supply Chain Resilience: Major Findings and Directions for Future Research." *International Journal of Production Economics* 171: 116–133.
- Kamalahmadi, M., and M. M. Parast. 2017. "An Assessment of Supply Chain Disruption Mitigation Strategies." *International Journal of Production Economics* 184: 210–230.
- Kesen, S. E., A. Kanchanapiboon, and S. K. Das. 2010. "Evaluating Supply Chain Flexibility with Order Quantity Constraints and Lost Sales." *International Journal of Production Economics* 126: 181–188.
- Ketokivi, M. 2006. "Elaborating the Contingency Theory of Organizations: The Case of Manufacturing Flexibility Strategies." *Production and Operations Management* 15 (2): 215–228.
- Kim, S. H., and S. Netessine. 2013. "Collaborative Cost Reduction and Component Procurement Under Information Asymmetry." *Management Science* 59 (1): 189–206.
- Kim, M., N. C. Suresh, and C. K. Hillmer. 2013. "An Impact of Manufacturing Flexibility and Technological Dimensions of Manufacturing Strategy on Improving Supply Chain Responsiveness: Business Environment Perspective." *International Journal of Production Research* 51 (18): 5597–5611.
- Kim, S. K., T. Yamada, and H. Kim. 2008. "Search for Alternatives and Collaboration with Incumbents: Two-Sided Sourcing Behavior in Business Markets." *Decision Sciences* 39 (1): 85–114.
- Kleindorfer, P. R., and G. H. Saad. 2005. "Managing Disruption Risks in Supply Chains." *Production and Operation Management* 14 (1): 53–68.
- Kochan, C. G., and D. R. Nowicki. 2018. "Supply Chain Resilience: a Systematic Literature Review and Typological Framework." *International Journal of Physical Distribution & Logistics* 48 (8): 842–865.
- Kouvelis, P., and J. Li. 2008. "Flexible Backup Supply and the Management of Lead-Time Uncertainty." *Production and Operations Management* 17 (2): 184–199.
- Leat, P., and C. R. Giha. 2013. "Risk and Resilience in Agri-Food Supply Chains: The Case of the ASDA PorkLink Supply Chain in Scotland." *Supply Chain Management: An International Journal* 18 (2): 219–231.
- Lee, H. L. 2002. "Aligning Supply Chain Strategies with Product Uncertainties." *California Management Review* 44 (3): 105–119.
- Lee, H. L. 2004. "The Triple-a Supply Chain." *Harvard Business Review* 82 (10): 102–113.
- Li, H., and M. Amini. 2012. "A Hybrid Optimisation Approach to Configure a Supply Chain for new Product Diffusion: A Case Study of Multiple-Sourcing Strategy." *International Journal of Production Research* 50 (11): 3152–3171.
- Li, J., and F. T. Chan. 2012. "The Impact of Collaborative Transportation Management on Demand Disruption of Manufacturing Supply Chains." *International Journal of Production Research* 50 (19): 5635–5650.
- Li, G., H. Fan, P. K. Lee, and T. C. Cheng. 2015. "Joint Supply Chain Risk Management: An Agency and Collaboration Perspective." *International Journal of Production Economics* 164: 83–94.
- Li, X., T. J. Goldsby, and C. W. Holsapple. 2009. "Supply Chain Agility: Scale Development." *International Journal of Logistics Management* 20 (3): 408–424.

- Lim, M. K., H. Y. Mak, and Z. J. Shen. 2017. "Agility and Proximity Considerations in Supply Chain Design." *Management Science* 63 (4): 1026–1041.
- Llorens, F. J., L. M. Molina, and A. J. Verdu. 2005. "Flexibility of Manufacturing Systems, Strategic Change and Performance." *International Journal of Production Economics* 98: 273–289.
- Lockamy, A., and K. McCormack. 2010. "Analysing Risks in Supply Networks to Facilitate Outsourcing Decisions." *International Journal of Production Research* 48 (2): 593–611.
- Lücker, F., and R. W. Seifert. 2017. "Building up Resilience in a Pharmaceutical Supply Chain Through Inventory, Dual Sourcing and Agility Capacity." *Omega* 73: 114–124.
- Melnyk, S. A., D. J. Closs, S. E. Griffis, C. W. Zobel, and J. R. Macdonald. 2014. "Understanding Supply Chain Resilience." *Supply Chain Management Review* 18 (1): 34–41.
- Melnyk, S., R. Lummus, R. Vokurka, L. Burns, and J. Sandor. 2009. "Mapping the Future of Supply Chain Management: A Delphi Study." *International Journal of Production Research* 47 (16): 4629–4653.
- Merschmann, U., and U. W. Thonemann. 2011. "Supply Chain Flexibility, Uncertainty and Firm Performance: An Empirical Analysis of German Manufacturing Firms." *International Journal of Production Economics* 130: 43–53.
- Moon, K. K., C. Y. Yi, and E. W. Ngai. 2012. "An Instrument for Measuring Supply Chain Flexibility for the Textile and Clothing Companies." *European Journal of Operational Research* 222: 191–203.
- Moreno, A., and C. Terwiesch. 2015. "Pricing and Production Flexibility: An Empirical Analysis of the U.S. Automotive Industry." *Manufacturing & Service Operations Management* 17 (4): 428–444.
- Moyaux, T., B. Chaib-draa, and S. D'Amours. 2007. "Information Sharing as a Coordination Mechanism for Reducing the Bullwhip Effect in a Supply Chain." *IEEE Transactions on Systems, Man, and Cybernetics-Part C: Applications and Reviews* 37 (3): 396–409.
- Namdar, J., X. Li, R. Sawhney, and N. Pra. 2017. "Supply Chain Resilience for Single and Multiple Sourcing in the Presence of Disruption Risks." *International Journal of Production Research* 56 (6): 2339–2360.
- Narasimhan, R., M. Swink, and S. W. Kim. 2006. "Disentangling Leanness and Agility: An Empirical Investigation." *Journal of Operations Management* 24: 440–447.
- Nooraie, S. V., and M. M. Parast. 2015. "A Multi-Objective Approach to Supply Chain Risk Management: Integrating Visibility with Supply and Demand Risk." *International Journal of Production Economics* 161: 192–200.
- Nooraie, S. V., and M. M. Parast. 2016. "Mitigating Supply Chain Disruptions Through the Assessment of Trade-Offs among Risks, Costs and Investments in Capabilities." *International Journal of Production Economics* 171 (1): 8–21.
- Oke, A., and M. Gopalakrishnan. 2009. "Managing Disruptions in Supply Chains: A Case Study of a Retail Supply Chain." *International Journal of Production Economics* 118: 168–174.
- Olson, E. G. 2010. "Supply Chain Opportunity in an Uncertain Economic Recovery." *Supply Chain Management: An International Journal* 15 (6): 488–492.
- Overby, E., A. Bharadwaj, and V. Sambamurthy. 2006. "Enterprise Agility and the Enabling Role of Information Technology." *European Journal of Information Systems* 15 (2): 120–131.
- Parast, M. M., and M. Shekarian. 2019. "The Impact of Supply Chain Disruptions on Organizational Performance: A Literature Review." In *Revisiting Supply Chain Risk. Springer Series in Supply Chain Management*. Vol. 7., edited by G. Zsidisin and M. Henke, 367–389. Cham: Springer.
- Patel, P. C., S. Terjesen, and D. Li. 2012. "Enhancing Effects of Manufacturing Flexibility Through Operational Absorptive Capacity and Operational Ambidexterity." *Journal of Operations Management* 30: 201–220.
- Peck, H. 2004. "Understanding the Sources and Drivers of Supply Chain Risk." In *The Financial Times Handbook of Management*. 3rd ed., edited by S. Crainer. London: Pearson Publishing.
- Pereira, C. R., M. Christopher, and A. L. Silva. 2014. "Achieving Supply Chain Resilience: the Role of Procurement." *Supply Chain Management: An International Journal* 19 (5/6): 626–642.
- Pettit, T. J., K. Croxton, and J. Fiksel. 2013. "Ensuring Supply Chain Resilience: Development and Implementation of an Assessment Tool." *Journal of Business Logistics* 34 (1): 46–76.
- Ponis, S. T., and E. Koronis. 2012. "Supply Chain Resilience: Definition of Concept and its Formative Elements." *The Journal of Applied Business Research* 28 (5): 921.
- Ponomarov, S. Y., and M. Holcomb. 2009. "Understanding the Concept of Supply Chain Resilience." *The International Journal of Logistics Management* 20 (1): 124–143.
- Prater, E., M. Biehl, and M. A. Smith. 2001. "International Supply Chain Agility - Tradeoffs Between Flexibility and Uncertainty." *International Journal of Operations & Production Management* 21 (5/6): 823–839.
- Qin, R., and D. A. Nembhard. 2010. "Workforce Agility for Stochastically Diffused Conditions- A Real Options Perspective." *International Journal of Production Economics* 125: 324–334.
- Revilla, E., and M. J. Saenz. 2017. "The Impact of Risk Management on the Frequency of Supply Chain Disruptions: A Configurational Approach." *International Journal of Operations & Production Management* 37 (5): 557–576.
- Rousseau, D. M., J. Manning, and D. Denyer. 2008. "Evidence in Management and Organizational Science: Assembling the Field's Full Weight of Scientific Knowledge Through Syntheses." *The Academy of Management Annals* 2 (1): 475–515.
- Saghafian, S., and M. P. Oyen. 2016. "Compensating for Dynamic Supply Disruptions: Backup Flexibility Design." *Operations Research* 64 (2): 390–405.

- Samvedi, A., V. Jain, and F. T. Chan. 2013. "Quantifying Risks in a Supply Chain Through Integration of Fuzzy AHP and Fuzzy TOPSIS." *International Journal of Production Research* 51 (8): 2433–2442.
- Sánchez, A. M., and M. Pérez. 2005. "Supply Chain Flexibility and Firm Performance: A Conceptual Model and Empirical Study in the Automotive Industry." *International Journal of Operations & Production Management* 25 (7): 681–700.
- Sawhney, R. 2006. "Interplay Between Uncertainty and Flexibility Across the Value-Chain: Towards a Transformation Model of Manufacturing Flexibility." *Journal of Operations Management* 24: 476–493.
- Scholten, K., and S. Schilder. 2015. "The Role of Collaboration in Supply Chain Resilience." *Supply Chain Management: An International Journal* 20 (4): 471–484.
- Sebastiao, H. J., and S. Golicic. 2008. "Supply Chain Strategy for Nascent Firms in Emerging Technology Markets." *Journal of Business Logistics* 29 (1): 75–91.
- Seuring, S., and M. Muller. 2008. "From a Literature Review to a Conceptual Framework for Sustainable Supply Chain Management." *Journal of Cleaner Production* 16 (15): 1699–1710.
- Sheffi, J. 2005. "Building a Resilient Supply Chain." *Harvard Business Review* 1 (8): 1–4.
- Sheffi, Y., and J. B. Rice. 2005. "A Supply Chain View of the Resilient Enterprise." *MIT Sloan Management Review* 47 (1): 41–48.
- Shekarian, M., S. V. R. Nooraie, and M. M. Parast. 2019. "An Examination of the Impact of Flexibility and Agility on Mitigating Supply Chain Disruptions." *International Journal of Production Economics* (in press).
- Simangunsong, E., L. C. Hendry, and M. Stevenson. 2012. "Supply-chain Uncertainty: a Review and Theoretical Foundation for Future Research." *International Journal of Production Research* 50 (16): 4493–4523.
- Simchi-Levi, D., H. Wang, and Y. Wei. 2018. "Increasing Supply Chain Robustness Through Process Flexibility and Inventory." *Production and Operations Management* 27 (8): 1476–1491.
- Sodhi, M. S., B. G. Son, and C. S. Tang. 2012. "Researchers Perspectives on Supply Chain Risk Management." *Production and Operations Management* 21 (1): 1–13.
- Sreedevi, R., and H. Saranga. 2017. "Uncertainty and Supply Chain Risk: The Moderating Role of Supply Chain Flexibility in Risk Mitigation." *International Journal of Production Economics* 193: 332–342.
- Stevenson, M., and M. Spring. 2007. "Flexibility From a Supply Chain Perspective: Definition and Review." *International Journal of Operations & Production Management* 27 (7): 685–713.
- Sudarto, S., K. Takahashi, and K. Morikawa. 2017. "Efficient Flexible Long-Term Capacity Planning for Optimal Sustainability Dimensions Performance of Reverse Logistics Social Responsibility: A System Dynamics Approach." *International Journal of Production Economics* 184: 179–192.
- Supply Chain Risk Managemet Council. 2011. Supply chain risk management: A compilation of best practices. Unpublished document. Online http://www.scrcl.com/articles/Supply_Chain_Risk_Management_A_Compilation_of_Best_Practices_final [1]. pdf.
- Swafford, P. M., S. Ghosh, and N. Murthy. 2006. "The Antecedents of Supply Chain Agility of a Firm: Scale Development and Model Testing." *Journal of Operations Management* 24: 170–188.
- Swierczek, A. 2014. "The Impact of Supply Chain Integration on the "Snow Ball Effect" in the Transmission of Disruptions: An Empirical Evaluation of the Model." *International Journal of Production Economics* 157: 89–104.
- Tang, C. S. 2006a. "Perspectives in Supply Chain Risk Management." *International Journal of Production Economics* 103 (2): 451–488.
- Tang, C. S. 2006a. "Perspectives in Supply Chain Risk Management." *International Journal of Production Economics* 103 (2): 451–488.
- Tang, C. S. 2006b. "Robust Strategies for Mitigating Supply Chain Disruptions." *International Journal of Logistics Research and Applications* 9 (1): 33–45.
- Tang, O., and S. Musa. 2011. "Identifying Risk Issues and Research Advancements in Supply Chain Risk Management." *International Journal of Production Economics* 133 (1): 25–34.
- Tang, C., and B. Tomlin. 2008. "The Power of Flexibility for Mitigating Supply Chain Risks." *International Journal of Production Economics* 116 (1): 12–27.
- Thun, J. H., M. Drüke, and D. Hoening. 2011. "Managing Uncertainty – An Empirical Analysis of Supply Chain Risk Management in Small and Medium-Sized Enterprises." *International Journal of Production Research* 49 (18): 5511–5525.
- Tomlin, B. 2006. "On the Value of Mitigation and Contingency Strategies for Managing Supply Chain Disruption Risks." *Management Science* 52 (5): 639–657.
- Tomlin, B., and Y. Wang. 2005. "On the Value of mix Flexibility and Dual Sourcing in Unreliable Newsvendor Networks." *Manufacturing & Service Operations Management* 7 (1): 37–57.
- Tranfield, D., D. Denyer, and P. Smart. 2003. "Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review." *British Journal of Management* 14: 207–222.
- Tsai, W. C. 2016. "A Dynamic Sourcing Strategy Considering Supply Disruption Risks." *International Journal of Production Research* 54 (7): 2170–2184.
- Tukamuhabwa, B. R., M. Stevenson, J. Busby, and M. Zorzini. 2015. "Supply Chain Resilience: Definition, Review and Theoretical Foundations for Further Study." *International Journal of Production Research* 53 (18): 5592–5623.

- Urciuoli, L., S. Mohanty, J. Hintsas, and E. G. Boekesteijn. 2014. "The Resilience of Energy Supply Chains: A Multiple Case Study Approach on oil and gas Supply Chains to Europe." *Supply Chain Management: An International Journal* 19 (1): 46–63.
- Wakolbinger, T., and J. M. Cruz. 2011. "Supply Chain Disruption Risk Management Through Strategic Information Acquisition and Sharing and Risk-Sharing Contracts." *International Journal of Production Research* 49 (13): 4063–4084.
- Wang, E. T., J. C. Tai, and H. L. Wei. 2006. "IT-enabled Virtual Integration as a Mechanism for Mediating the Impact of Environmental Uncertainty on Supply Chain Performance." In Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06), Vol. 1, 7c-7c. Kauia: Institute of Electrical and Electronics Engineers (IEEE).
- Wang, T., D. J. Thomas, and N. Rudi. 2014. "The Effect of Competition on the Efficient Responsive Choice." *Production and Operations Management* 23 (5): 829–846.
- Wu, T., J. Blackhurst, and P. O'grady. 2007. "Methodology for Supply Chain Disruption Analysis." *International Journal of Production Research* 45 (7): 1665–1682.
- Xiaoqiang, Z., and F. Huijiang. 2009. *Response to the Supply Chain Disruptions with Multiple Sourcing*. Automation and Logistics, ICAL. Shenyang: Institute of Electrical and Electronics Engineers (IEEE).
- Yang, T., and W. Fan. 2016. "Information Management Strategies and Supply Chain Performance Under Demand Disruptions." *International Journal of Production Research* 54 (1): 8–27.
- Yang, Y., S. Pan, and E. Ballot. 2017. "Mitigating Supply Chain Disruptions Through Interconnected Logistics Services in the Physical Internet." *International Journal of Production Research* 55 (14): 3970–3983.
- Yi, C. Y., E. W. Ngai, and K. L. Moon. 2011. "Supply Chain Flexibility in an Uncertain Environment: Exploratory Findings From Five Case Studies." *Supply Chain Management: An International Journal* 16 (4): 271–283.
- Yu, K. 2013. "The Effects of Objective and Perceived Environmental Uncertainty on Supply Chain Flexibility." In 10th International Conference on Service Systems and Service Management, 410–415. Hong Kong: Institute of Electrical and Electronics Engineers (IEEE).
- Yu, K., J. Cadeaux, and H. Song. 2013. "Distribution Channel Network and Relational Performance: The Intervening Mechanism of Adaptive Distribution Flexibility." *Decision Sciences* 44 (5): 915–950.
- Zeng, B., and B. P. Yen. 2017. "Rethinking the Role of Partnerships in Global Supply Chains: A Risk-Based Perspective." *International Journal of Production Economics* 185: 52–62.
- Zhang, Q., M. A. Vonderembse, and J. S. Lim. 2002. "Value Chain Flexibility: A Dichotomy of Competence and Capability." *International Journal of Production Research* 40 (3): 561–583.
- Zhang, Q., M. A. Vonderembse, and J. S. Lim. 2003. "Manufacturing Flexibility: Defining and Analyzing Relationships among Competence, Capability, and Customer Satisfaction." *Journal of Operations Management* 21: 173–191.
- Zhao, L., and A. Huchzermeier. 2017. "Integrated Operational and Financial Hedging with Capacity Reshoring." *European Journal of Operational Research* 260: 557–570.
- Zsidosin, G. A., and S. M. Wagner. 2010. "Do Perceptions Become Reality? The Moderating Role of Supply Chain Resiliency on Disruption Occurrence." *Journal of Business Logistics* 31 (2): 1–20.