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Decision-making models for supply chain risk mitigation: A review

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ABSTRACT

This paper presents a systematic literature review and a comprehensive analysis of the decision-making models for supply chain risk (SCR) mitigation. In all, 538 research articles published from 2005 to 2016 in the Academic Journal Guide quality rated journals have been collected and a further 126 articles were shortlisted for the final review. The objectives of the review are to (i) identify the major research concepts in SCR mitigation (ii) identify SCRs, mitigation strategies, and the decision-making models most addressed by scholars working on SCR mitigation, (iii) study the relationship between the mitigation strategies and the modelling techniques used, and (iv) study the relationship between the risk measures, decision maker's risk attitude, and the modelling techniques used. An integrated research focus parallelship network and keyword co-occurrence network analysis has been carried out using BibExcel and Gephi to identify the major areas in SCR mitigation. Our results suggest that disruption, demand, and supply risks have received much attention while reputation, credit, exchange rate and information risks are least addressed. Robust/resilient supply chain network design and risk propagation analysis, sourcing/supplier selection and order allocation, reliable facility location/fortification and inventory management, and co-ordination, pricing and risk sharing contracts are the major research concepts in SCR mitigation. Stochastic programming and mixed integer linear programming are the commonly studied modelling methods.

1. Introduction

The uncertainties associated with demand, supply, cost, lead time, and frequent catastrophic disasters can result in severe economic losses, poor customer service, and reputation loss of business. The Allianz Risk Barometer (2016) highlighted that supply chain disruption, market volatility, and cyber incidents were major commercial risks. Attesting to this, a recent flood in Chennai (India) resulted in a US $2.2 billion loss in the global supply chain (Re, 2016). Further, other studies showed that adopting lean and just-in-time practices for buffer reduction can leave the firm at risk during a disruption (Snyder et al., 2016). As such, scholars have developed models and methods for managing supply chain risks. Supply chain risk management (SCRM) is a systematic phased approach for identifying, assessing, prioritizing, mitigating, and monitoring potential disruptions in the supply chain in order to reduce the negative impact of these disruptions in supply chain operations (Aqlan & Lam, 2016). The likely risks and their factors in a supply chain are determined in the risk identification phase followed by the prioritization of risks through estimating their likelihood of occurrence and impact on the supply chain in the risk assessment phase. In the risk mitigation phase, the most appropriate mitigation strategy for each risk or each combination of risks is identified (Khan & Burnes, 2007).

Most reviews on SCRM are narrative (see Table 1). A systematic literature review is preferred to the narrative as it is replicable, scientific, evidence-based, and transparent (Tranfield, Denyer, & Smart, 2003). Earlier reviews on SCRM have focused on the holistic SCRM process (Ghadge, Dani, & Kalawsky, 2012; Heckmann, Comes, & Nickel, 2015; Ho, Zheng, Yildiz, & Talluri, 2015; Tang & Musa, 2011), sources of risk (Heckmann et al., 2015; Kleindorfer & Saad, 2005; Rao & Goldsby, 2009; Simangunsong, Hendry, & Stevenson, 2012; Tang, 2006), and risk classification (Rangel, de Oliveira, & Leite, 2015; Natarajarathinam, Capar, & Narayanan, 2009; Tang & Musa, 2011). Ho et al. (2015) and Ghadge et al. (2012) highlighted that the SCR mitigation process has gained more attention (nearly 60%) among the other phases of SCRM.

Only a few scholars have reviewed risk mitigation (Arshinder, Kanda, & Deshmukh, 2011; Snyder et al., 2016; Tang, 2006), their modelling approaches (Fahimnia, Tang, Davarzani, & Sarkis, 2015; Peidro, Mula, Poler, & Lario, 2009), risk measures (Chiu & Choi, 2013; Heckmann et al., 2015; Klibi, Martel, & Guitouni, 2010; Snyder, 2006; Kleindorfer & Saad, 2005), and a decision maker's risk attitude

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Table 1
Reviews on SCRM.

No.	Author(s)	No. of papers reviewed	Review type		Holistic SCRM phases	Mitigation phase	Risk modelling techniques	Risk measures	Risk attitude	Network analysis
			NLR	SLR						
1	Snyder et al. (2016)	180	✓			✓	✓			
2	Fahimnia et al. (2015)	1000		✓	✓					✓
3	Heckmann et al. (2015)	33	✓		✓		✓	✓	✓	
4	Ho et al. (2015)	224	✓		✓		✓			
5	Rangel et al. (2015)	16	✓		✓					
6	Chiu and Choi (2013)	52	✓					✓		
7	Colicchia and Strozzi (2012)	55		✓	✓					✓
8	Ghadge et al. (2012)	120		✓	✓		✓			✓
9	Simangunsong et al. (2012)	*	✓		✓					
10	Arshinder et al. (2011)	*		✓		✓				
11	Tang and Musa (2011)	138	✓		✓					✓
12	Klibi et al. (2010)	*	✓		✓		✓	✓		
13	Olson and Wu (2010)	*	✓		✓				✓	
14	Natarajarathinam et al. (2009)	118	✓		✓		✓			
15	Peidro et al. (2009)	103	✓		✓		✓			
16	Rao and Goldsby (2009)	55	✓		✓				✓	
17	Vanany, Zailani, and Pujawan (2009)	82	✓				✓			
18	Khan and Burnes (2007)	*	✓		✓					
19	Snyder (2006)	*	✓				✓	✓		
20	Tang (2006)	200	✓			✓			✓	
21	Kleindorfer and Saad (2005)	*	✓		✓			✓		
	Our paper	126		✓		✓	✓	✓	✓	✓

* Number of papers reviewed was not specified; NLR- Narrative literature review; SLR- Systematic literature review.

(Heckmann et al., 2015; Olson & Wu, 2010; Rao & Goldsby, 2009; Tang, 2006). This suggests a paucity in the literature.

To address this research gap, we present a systematic literature review of supply chain risk mitigation based on co-occurrence analysis. Specifically, we review the modelling approaches, risk measures, and decision maker's risk attitude as shown in Table 1. A total of 538 research articles, published from 2005 to 2016 in the Academic Journal Guide (AJG) quality rated journals were collected, and 126 articles were shortlisted for the review. The objectives of the review are to (i) identify the major research concepts in SCR mitigation (ii) identify SCRs, mitigation strategies, and the decision-making models most addressed by scholars working on SCR mitigation, (iii) study the relationship between the mitigation strategies and the modelling techniques used, and (iv) study the relationship between the risk measures, decision maker's risk attitude, and the modelling techniques used.

The rest of this paper is organized as follows: Section 2 reports the proposed systematic literature review based on co-occurrence analysis. The results and discussions of the co-occurrence network analysis are presented in Section 3. A comprehensive analysis of the reviewed papers highlighting the relationships between the risk measures, decision maker's risk attitude, and the modelling techniques used are also reported in Section 3. Finally, the research gaps and future research directions are highlighted in Section 4.

2. Review method

Following Denyer and Tranfield (2009), a four phase systematic literature review methodology was proposed for selecting the research papers and their analyses to identify the major research streams in SCR mitigation (see Fig. 1).

Phase I: Research planning

Phase I involved formulating the research objectives and questions. Our questions of interest included: (i) what are the major research concepts in SCR mitigation? (ii) what are the most addressed SCRs, mitigation strategies, and the decision-making models studied by scholars in SCR mitigation? (iii) what is the relationship between the mitigation strategies and the modelling techniques used? and (iv) what is the relationship between the risk measures, decision maker's risk attitude, and the modelling techniques used?

Phase II: Locating studies and evaluation

After formulating the research questions, the articles for the study were identified and screened. Following the works of Miemczyk, Johnsen, and Macquet (2012), Wong, Skipworth, Godsell, and Achimugu (2012), and Chicksand, Watson, Walker, Radnor, and Johnston (2012), the articles for review were identified from quality rated journals under "Operations and Technology Management" (O & TM) and "Operations Research and Management Science" (OR/MS) published in the AJG (2015) by the Association of Business Schools. The AJG (2015) categorizes the business and management journals into 22 subject areas and ranked them into five categories (1–4 and 4*) with 4* being a Journal of Distinction category. The AJG (2015) rating of a journal was measured based on the standardized citation impact factor score and evaluations conducted by subject experts and leading academics in their area. The measured citation impact score was the standardized value of five year Journal Citation Report rating and the three year SCImago Journal Rank and Source Normalized Impact per Paper ratings. A journal of rating 4 had the highest citation impact factor in their field with very few journals of rating 1 carrying a citation impact factor. A journal of rating 4 was upgraded to 4* if it was rated in the highest category by at least three out of the five non-university based listings (The Association of Business Schools, 2015). Papers published in journals with an AJG rating of 4*, 4 or 3 were considered in this work in order to perform a high quality review (Ghadge et al., 2012). However, one journal with an AJG rating of 2 and two journals of AJG ratings of 3 and 4 from "Sector Studies" were included after considering their number of publications on SCR mitigation. Appendix A contains the list of journals considered for our study along with their AJG ratings. The shortlisted articles were accessed from IEEE Xplore, Elsevier, Springer's Link, ACM Digital Library, Taylor and Francis, Emerald Insight, INFORMS PubsOnLine, Wiley Online Library, and Palgrave Macmillan journals.

A 3-level keyword formulation, as shown in Table 2, was followed to

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