

Chapter 18

Building a Natural Disaster Risk Index for Supply Chain Operations

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ABSTRACT

Risk for an organization is associated with uncertainties in all areas of its operations. As firms move toward global sourcing, supply chain risk increases dramatically, which is linked to lower financial performance and market value. One major type of supply chain risk is disruptions caused by natural or man-made disasters. In this paper, major factors causing supply chain disruptions are identified based on resource dependency theory and contingency theory. As a result of the study, a comprehensive supply chain risk index for natural disasters is proposed by including two major factors (i.e. location and single source). Actions are suggested for supply chain managers to lower disruption risks within a supply chain when they use the risk index as a measure.

1. INTRODUCTION

Risk from uncertainty has been extensively researched in various business fields such as finance, operations, and marketing. Supply chain risk has recently been given increased attention by firms and researchers, since it has a negative impact on market and financial performances (Fortune, 2011; Tang, 2006). The estimated costs of natural disasters for Japan are \$210 billion in 2011 (Fortune, 2011). Supply chain risks include operational risks and disruption risks; operational risks are caused by normal uncertainties from supply, demand, and cost, while disruption risks are caused by natural or man-made disasters (Tang,

DOI: 10.4018/978-1-5225-5481-3.ch018

2006). This study identifies major supply chain risk factors based on resource dependency theory and contingency theory: the weak part of the supply chain, such as the single supply issue and the possibility of natural disaster at the facility location and logistics network. Moreover, a new model of a supply chain risk index under natural disasters is proposed by including the two major factors above: location and single supply. Actions are suggested to industrial managers to lower disruption risks within a supply chain when the risk index is used as a measure.

The study is organized as follows. Next section presents the literature review followed by theories and the conceptual model. The risk index for natural disasters and suggestions for improvement are described in the next section. Conclusions are in the last section.

2. LITERATURE REVIEW

As a result of organizations becoming more engaged in offshore manufacturing and global outsourcing practices, as well as a recent series of natural disasters (hurricanes, powerful earthquakes, floods), supply chain risk management has started taking center stage as a vital priority for many organizations. Those events triggered enormous disruptions to many supply chains. Organizations have come to realize that a resilient supply chain will secure organization's competitiveness whereas fragile supply chains will threaten organization's position in the market. Researchers have also reacted by focusing on this rapidly-developing field of supply chain risk management. As a result, a large number of researchers have become interested in the area as identified in a recent literature review by Rao & Goldsby (2009). The study revealed that "the recent past has seen a surge in interest of researchers and practitioners in the area of supply chain risk". In another literature review, Vanany *et al.* (2009) examined relevant articles published in supply chain risk management field from 2000 to 2007. The authors classified articles according to four basic supply chain areas: supply management, product management, information management, and demand management. Tang & Musa (2011) have also investigated the research tendency of the supply chain risk management area through a comprehensive literature review. Based on the review, they concluded that there is an increasing interest in the field. Additionally, their study focused on major risk issues and risk mitigation techniques based on material, information and financial flows. As a result of their study identifying a gap in the literature, the authors attempted to propose several quantitative techniques that could be used for risk management: (i) robust planning, (ii) revenue management, (iii) agency theory, (iv) option theory, (v) reverse logistics, and (vi) system dynamics.

Literature on supply chain risk management has been growing as evidenced by the increased number of research studies that came out over the past few years. Some studies focused on defining the supply chain risk (Harland *et al.*, 2003; Zsidisin, 2003a) whereas some others focused on identifying the sources of supply chain risks (Chopra & Sodhi, 2004; Juttner *et al.*, 2003; Juttner, 2005; Zsidisin, 2003b; Christopher *et al.*, 2011; Wagner & Bode, 2008). Some looked into the relationship between supply chain risks and supply chain performance (Ritchie & Brindley, 2007; Hendricks *et al.*, 2005a; Hendricks *et al.*, 2005b); some other studies suggested some effective strategies to mitigate the supply chain risk as well as developed some models to manage the supply chain management risk (Christopher & Lee, 2004; Juttner, 2005; Finch, 2004; Faisal *et al.*, 2006; Christopher & Peck, 2004; Barry, 2004; Giunipero & Eltantawy, 2004; Ritchie & Brindley, 2007; Manuj & Mentzer, 2008; Tummala & Schoenherr, 2011). Some papers focused on how IT systems could be utilized to support supply chain risk management initiatives. For

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