

# Risk and Risk Aversion in Supply Chain Management



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## INTRODUCTION

Globalization and free trade around the world have forced the business enterprises to face even tougher challenges than before to survive in the competitive markets today. Companies are collaborating more closely with their upstream and downstream entities in order to design better value chains to reduce cost and satisfy customers. At the same time, they are adopting newer and better strategies to mitigate various risks that their companies are exposed to and achieve supply chain performance.

In general, *risk* can be defined as the direct or indirect undesirable consequences of controllable or uncontrollable events which affect an individual, a section of individuals or a society at large. *Supply chain risk* can be defined as the deviation of system profit from expectation as a result of unforeseeable and uncertain events occurred. This risk is of various types such as operational risk, external/internal hazards risk, risk of globalization, financial risk, risk due to technological innovations, etc. Several recent major events and their consequences on business have demonstrated the need to address risk in supply chain. For example, the fire that took place in the Phillips semiconductor plant in Albuquerque, New Mexico, in 2000, caused its major customer, Ericsson, to lose \$400 million in potential revenues. Another example is Hurricane Katrina (in 2005) for which 10% - 15% of total U.S. gasoline production was halted. As a result, oil price in U.S. was spiked. More recent example includes shutdown of all air traffic in Norway and much of Northern Europe for a few days (in April, 2010) due to a volcano eruption in Iceland causing an ash cloud to drift into European airspace.

Increasing globalization has opened the door for fantastic business opportunities today, but at the same time it increases supply chain risks. Any company operating across multiple borders must understand the importance of properly managing their supply chains in the face of this ever-changing world. The natural disaster (earthquake and tsunami) in Japan in 2011 has proved the global impact of the incident on shipping and sourcing to and from and thereby, supply chain. Companies across the globe are being affected by the financial crisis due to economic downturn. Although several other factors such as high customer expectations, customer preference/test change, supply and demand uncertainties, and mergers and acquisitions impose external pressures, organizations have to redesign their strategies to mitigate supply chain risks in order to survive in the globally competitive business environment.

By conducting a survey on 67 manufacturing plants in the German automotive industry, Thun and Hoenig (2009) investigate in an empirical analysis of supply chain risk management and find that the companies who use reactive risk management approach do better in terms of disruptions resilience or reduction of the bullwhip effect, whereas the companies who pursue preventive risk management approach seem to do better as to flexibility or safety stocks. Kern et al. (2012) develop a supply chain model for upstream risk management and test the performance using least square analysis on survey data collected from 162 large and medium sized manufacturing companies located in Germany. They explore that superior risk identification methodology adopted by a company supports the subsequent risk assessment process which in turn leads to better risk mitigation of the

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supply chain. However, in practice, the majority of companies continue to underestimate supply chain risks and fail to take appropriate approaches to mitigate the risks proactively. Decision makers usually develop traditional supply chain models that determine the optimal decentralized decisions for the entities involved in the chain by maximizing (minimizing) the expected profit (cost). This approach is particularly appropriate to risk-neutral decision makers. However, there are individuals who are risk-averse *i.e.*, they are willing to trade off lower expected profit for downside protection against possible losses or to accept some degree of increased expected cost in order to reduce the variability of the cost. Traditional supply chain models, therefore, fall short of meeting the needs of risk-averse decision makers. The primary objective of this chapter is to provide an overview of different kind of emerging risks in supply chain, risk management framework and various optimality criteria usually adopted by risk-averse decision makers. The chapter is organized as follows: Relevant past and recent researches focused on supply chain risk management are outlined in the following section. The next section deals with major risk factors which are prevailed in supply chain, and risk management framework. The following section discusses several risk-sensitive decision making criteria. Finally, the chapter is concluded with some remarks and potential future research agenda.

## **LITERATURE REVIEW**

Supply chain risk management has attracted the attention of many researchers and practitioners recently, as failure to mitigate the prospective risks properly may incur enormous losses to enterprises. Gaonkar and Viswanadham (2007) attempt to develop a conceptual framework in order to classify various supply chain risks and approaches that can be used to deal with those risks. Research on inventory/supply chain risk began to embed supply disruptions into classical inventory models,

assuming that a firm's supplier might experience a disruption when the firm wished to place an order (see Zipkin, 2000; Nahmias, 2005). Qi et al. (2004) provide centralized and decentralized coordination models and test a firm's operating plan in a one-supplier one-retailer setting in the presence of disruption risk. Kleindorfer and Saad (2005) provide a conceptual framework for managing disruption risks in supply chains. Tomlin (2006) explores contingency strategies to minimize risk exposure to supply chain disruptions. Papadakis (2006) analyzes financial performance of supply chain after disruptions. He demonstrates decrease in company's stock price as a reaction of supply chain disruptions. Chopra et al. (2007) evaluate the error that results from bundling disruptions and yield uncertainty when making replenishment decisions. Giri (2011) investigates the dual sourcing strategy under disruption risk when retailer's demand and supplier's yield are uncertain. A comprehensive review of supply chain disruption risks is provided by Natarajarathinam et al. (2009) who observe that most of the researches until that time focus on external sources and proactive approaches that can be utilized at the time of crisis in supply chain.

Chopra and Sodhi (2004) classify risk categories into disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity. They are in the opinion that there is no simple way out to mitigate supply chain risk because implementation of one strategy to mitigate a particular risk may lead the supply chain to face other risk. They stress on the importance of common understanding of supply chain risks by all the participating members. Fernandes et al. (2010) introduce the relevance of a systematic approach for the identification, quantification and mitigation of risks, and present a practical risk management framework for petroleum supply chain. Neiger et al. (2011) propose a novel value-focused process engineering methodology for process-based supply chain risk identification. Recently Sun et al. (2012), and Tse and Tan (2012) discuss quality risk management

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