Chapter 8

A Theoretical Framework for a Simulation–Based Analysis of Supply Chain Risk Management

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ABSTRACT

Supply chain management under uncertainty and risk has become the target of extensive research. A review of the corresponding literature indicates mainly theoretical approaches, which attempt to provide solutions to certain problems. In this chapter, a theoretical framework of supply chain risks analysis is proposed. Within this framework, studied risks are determined by possible disruptions that affect supply chain ability to function normally. Thus, supply chain performance parameters are taken as a basis for a risk measurement system. Correspondingly, supply chain reliability parameters and performance fluctuations are studied in order to manage risks. A possible implementation of the proposed framework is discussed through the presentation of a simulation example. Still, the evaluation of the proposed framework’s practical application remains an item of the future research agenda. The ultimate objective of the research presented in this chapter is the elaboration of a software solution for supply chain modelling and risk evaluation.

INTRODUCTION

Nowadays, the application of logistics techniques is becoming a common and important part of business management. Current logistics achievements which require the use of modern information technologies allow the creation of complex management systems that potentially provide a great profit. At the same time, these complex systems contain many risks that can seriously disrupt business activities.

Supply chain is perceived as a complex organizational form which is very sensitive to possible

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disruptions due to a high level of interdependencies between the activities of its member companies. On the other hand, cooperation between members provides a wide range of opportunities for supply chain disruption mitigation. Still, supply chain risk management is a quite new research area, which became the target of intensive research only a few years ago. An analysis of the corresponding literature reveals several approaches to supply chain risk management which mostly study how internal disruptions within firms can affect supply chain functionality. In addition, few are the studies that make good use of quantitative risk measurement systems.

This chapter proposes a theoretical framework for risk analysis in the context of supply chain management. The examined risks are connected with disruptions which are generally external to most supply chain members. First, the structure of a supply chain and basic performance parameters are the target of careful analysis. Then, a quantitative cost-based indicator which can be used for the effective measurement of identified risks is developed. In that sense, simulation is recognized as the most suitable instrument for studying the aforementioned performance parameters, which are used within the proposed risk analysis concept.

**BACKGROUND**

Literature regarding logistics and supply chain risk management is vast. A brief analysis indicates not only the large variety of risk management approaches, but also different types of risk perception within supply chain systems. This lack of standardization sometimes creates a relative confusion which attempts to address by providing a short but to the point discussion on supply chain risk management.

**RISK AND UNCERTAINTY**

First, the different perceptions on the terms of risk and uncertainty should be discussed. Though these terms have been the object of very extensive research in various scientific directions for many years, the clear and unique formulations of their meaning have not been stated yet (Brindley & Ritche, 2004). It is possible to define at least two basic schools of thought on the issue of whether risk and uncertainty have the same meaning. Some publications do not make a sharp distinction between the meanings of risk and uncertainty. Another way to distinguish between the two terms relies on the ability to make probability assessments: risk corresponds to events that can be associated with given probabilities; and uncertainty corresponds to events for which probability assessments are not possible (Chanvas, 2004; Borodzicz, 2005; Crouhy, Galai & Mark, 2006). This suggests that risks are easier to evaluate than uncertainties. It is also necessary to point out that unexpected profit is discussed as a possible risk variation in the context of financial management (Shapkin, A. & Shapkin, B., 2005). Still, these risks are beyond the scope of this chapter.

In the proposed research, any potential harm that may arise in the future due to current operation or some future events constitutes risk. It is suggested that any risk appears due to a changing environment formed by different uncertainties, and uncertainty is recognized as a negative characteristic of an environment (Cucchiela & Gastaldi, 2006; Waters 2007). Thus, the following risk definition is used: risk is any uncertainty that affects a system in an unknown fashion; its ramifications are unknown, but it brings great fluctuation in value and outcome (Mun, 2006). It should be noticed that each uncertainty can cause a risk event in the future, yet not all uncertainties produce risk for the operation of certain systems.
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