Chapter X
Towards a Methodology for Monitoring and Analyzing the Supply Chain Behavior

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ABSTRACT

In this chapter, the authors present general steps towards a methodology that contributes to the advancement of prediction and mitigation of undesirable supply chain behavior within short- and long- term horizons by promoting a better understanding of the structure that determines the behavior modes. Through the integration of tools such as system dynamics, neural networks, eigenvalue analysis, and sensitivity analysis, this methodology (1) captures the dynamics of the supply chain, (2) detects changes and predicts the behavior based on these changes, and (3) defines needed modifications to mitigate the unwanted behaviors and performance. In the following sections, some background information is given from literature, the general steps of the proposed methodology are discussed, and finally a case study is briefly summarized.

INTRODUCTION

In today's business environment, supply chain management (SCM) plays a crucial role in modern companies endeavoring to uphold their competitive advantages. In the past, most of the managerial practices employed to control the supply chain relied mainly on monitoring data with respect

to sales, demand, and inventory levels so as to react appropriately when needed. The implicit assumption was that demand and supply would remain predictable, which was valid in a market that was dominated by the supplier's perspective, not the consumer's. Today, an effective SCM involves the management of supply chain assets, products, information, and fund flows if a company is to maximize total supply chain profitability (Chopra & Meindl, 2007). The long-term goal of maximizing total profitability in SCM is multidimensional in nature and translates into cost minimization, increased levels of service, improved communication among partners, and increased flexibility in terms of delivery and response (Lancioni, Smith, & Oliva, 2000). All these dimensions represent conflicting objectives that make the decision making process throughout the supply chain more complex. In addition, a supply chain is a complex dynamic system consisting of a hierarchical nesting of both continuous and discrete dynamics. Therefore, modeling plays a fundamental role in both analysis and improving the supply chain.

In practice, due to the complexity observed in supply chain systems, diverse research has been required to design and analyze a supply chain system by using different modeling approaches. Most approaches fall into one out of four main categories of methodology: continuous time differential equation models, discrete time difference models, discrete event models, and classical operational research methods. In the latter case, researchers have studied the application of various operations research techniques to analyze supply chain problems (Anderson & Marklund, 2000; Bose & Pekny, 2000; Jayaraman & Pirkul, 2001; Lakhal, Martel, Kettani, & Oral, 2001; Riddalls, Bennett, & Tipi, 2000; Shapiro, 2001). Riddals et al. (2000), however, said that none of the operations research techniques is best, and none are worthless. These techniques may be of unique benefit at the tactical level, but they certainly fail to provide insights into the dynamic behavior of the supply chain as whole. However, simulation models based on dynamics of systems may be the only way to study phenomena like the demand amplification, where small fluctuations in demand at the retailer end of the supply chain are augmented as they advance through the supply chain. The interested reader is referred to works by Riddals et al. (2000) and Beamon (1998) for a more comprehensive review of the models and methods used in the literature.

In this chapter, general steps towards a methodology are introduced to monitor and analyze the supply chain behavior patterns. Additional information emphasizing other aspects of this methodology has been recently published by Rabelo, Helal, Lertpattarapong, Moraga, and Sarmiento (in press). The proposed methodology contributes to the advancement of prediction and mitigation of undesirable supply chain behavior within short- and long-term horizons by promoting a better understanding of the structure that determines the behavior modes through the integration of tools such as system dynamics, neural networks, eigenvalue analysis, and sensitivity analysis. It is imperative for manufacturing industries to equip themselves with tools to detect changes in the supply chain behavior due to external and/or internal factors and be prepared to counteract any undesirable consequences. This methodology (1) captures the dynamics of the supply chain, (2) detects changes and predicts the behavior based on these changes, and (3) defines needed modifications to avoid (or mitigate) the unwanted behaviors and performance. In the following sections, some background information is given from the literature, the general steps of the proposed methodology are presented, and finally a case study is briefly summarized.

LITERATURE BACKGROUND

The use of simulation techniques is having a significant impact in SCM for modeling and