Chapter 13
Designing a Dynamic Buyer–Supplier Coordination Model in Electronic Markets Using Stochastic Petri Nets

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ABSTRACT

Functional relationship between supplier and buyer in an open market place leads to investigate the role of both quantifiable and non-quantifiable parameters in coordination mechanism with the aim of achieving higher performance in supply chain activities. Here, we develop a supply chain model and a new agent to analyze and simulate the players’ behavior in the network. A cooperative game theory framework is utilized between buyer and supplier in order to increase the supply chain performance. The study is supported by presenting SC Net Optimizer as a tool for implementing the proposed coordination mechanism and evaluates the performance of the chain by simulation using stochastic Petri nets (SPNs). The model provides a more realistic optimization process by taking into consideration the dynamic information flow in an uncertainty environment.
INTRODUCTION

Globalization of market competition, reducing gap between products in terms of quality and performance are compelling the researchers to rethink about ways to manage business operations more efficiently and effectively (Sarmah, Acharya, & Goy, 2006). Electronic market has added a new dimension to the investigation of the business relationship. Electronic markets are defined as a network information system that serves as enabling infrastructure for buyers and sellers to exchange information, transact, and perform other related activities (Lancastre & Lages, 2006). The benefits of e-environments motivate the researchers to align and coordinate the business processes and activities of the net members dynamically as well as to improve the overall performance of supply chain strategies.

A supply chain can be viewed as a network with the entities possibly owned by owners in geographically diverse locations. Supply chain management (SCM) benefits from a variety of concepts that were developed in several different disciplines as marketing, information systems, economics, system dynamics, logistics, operational management, and operations research. In the literature, supply chains are usually described as multi-echelon inventory systems. However, most existing models can only describe a restricted class of supply chains with simplifications (Chen, Lionel, Chu, & Labadi, 2005). For instance, most multi-echelon inventory models don’t explicitly take account of transportation operations and capacity constraints in supply chain by simply assuming a constant lead time between any two adjacent stocking locations (Tayur, Ganeshan, & Magazine, 1998). These models lack flexibility and generality in describing real-life supply chains. The coordination, however, is quite difficult because of the inherent complexity and uncertainty of the supply chains.

Here, we view the supply chain as a discrete event dynamic system (DEDS) and the research is geared towards providing the mathematical model that can describe material, information, and financial flows of a decentralized supply chain in an integrated way. This provides a tool, which can help industrial practitioners to model, evaluate performance, and optimize operational policies of their supply chains. In the next section, we provide a brief literature review about coordination mechanism.

The rest of this article is organized as follows: In background, the literature on coordination mechanism in both centralized and decentralized supply chain, game theory, agent, and simulation-based approaches in supply chain is reviewed. In the next section, system architecture, detailed mechanisms of the model and supply network strategy are presented. The scenario statement of small supply network section describes the details of implementing the simulation and develops the scenario design. Moreover, some discussions are provided for performance criteria of supply chain. Finally, the conclusions and some guidelines for future research are presented.

BACKGROUND

Coordination Mechanism

Several strategies such as credit option, buy/back return policies, quantity flexibility, and commitment of purchase quantity are used to align the business process and activities of diverse members of supply chains in terms of cost, response time, timely supply, and customer service (Sarmah et al., 2006). They particularly investigate SC coordination models that have used quantity discount as a coordination tool under deterministic environment, which has received much attention in production/operation management.

Supply chain coordination is concerned with the development and implementation of such strategies. There is no universal coordination strategy that will be efficient and effective for all
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