Chapter 3
Software Agents Mediated Decision Simulation in Supply Chains

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ABSTRACT

The concept of software agent has become important in both artificial intelligence and mainstream computer science. Multi-agent systems (MAS) are providing the way to design and implement information system solutions that exhibit flexibility, adoptability and reconfigurability in a distributed environment, which are main benefits over traditional centralized software systems. The analysis, design, deployment and testing of such distributed agent-based software systems, particularly those exhibiting intelligent decision-making properties, are usually a challenging task. Simulation plays a key role to analyse the behaviour of MAS solutions during the analysis and design phase of automated software solution. This chapter uses the concept of multi-agent computing and presents software architecture for green supply chain management, in particular carbon footprint assessment planning for a multi-modal transportation problem. In this architecture, all the software agents' operations are governed by a hybrid knowledge-based which utilizes case-based reasoning (CBR) and rule-based reasoning (RBR). The describe architecture accepts a transportation service request and plans a transportation strategy with a minimum environmental impact (i.e. CO2 footprint), by retrieving best practices (from a carbon footprint perspective) for each route leg, from a repository of best practiced cases. Carbon footprint best practices from each route leg in a multi-modal transportation scenario are used to minimize environmental impact and thus demonstrate system functionality.

INTRODUCTION

Supply chains are important part of every economy and every business (Pal & Karakostas, 2014). A supply chain is a network of business units that enables the purchasing of raw materials, their transformation into ultimate products and the delivery of these products to customers through dedicated distribution and

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transportation facilities. In a typical retail supply chain, raw materials are purchased from suppliers and products are manufactured at one or more production plants. Then they are transported to intermediate storage (e.g. warehouse, distribution center) for packaging and shipping to retailers or customers. The path from supplier to customer can include a few intermediaries such as wholesalers, warehouses, and retailers, depending on the products and markets. In this way, supply chain management (SCM) uses operational practices which ensure efficient integration of suppliers and customers, so merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, to optimize system wide costs while producing value for money to its customers. Such systems need to link diverse business-partners for day-to-day operational planning purpose. Business partnership between companies leads to the creation of a *"channel"* through which one identify three diverse types of flow (materials, money, and information). As supply chain networks are becoming more and more global, business activities co-ordination must be considered a key issue for successful operation management. Figure 1 shows a simple diagrammatic representation of a retail supply chain, which highlights some of the main internal business activities.

The focus of SCM is shifting from operational aspects of manufacturing engineering, whose main objectives is to get matrix-based efficiency, to supply chain activities coordination aiming at global efficiency. The need for suitable management and communication frame-work is thus becoming more and more essential for global supply chain management purpose.

In order to understand the importance of changes taking place in business-partners integration initiatives along supply chain, it would be judicious to review trends in production and operations management. First, the huge worldwide competition and the highly specified customers' requirements towards product quality, delivery time, and services force the supply chain industry to a real-time (or nearly real-time) optimization of their production and transportation business processes. Second, the change towards demand driven manufacturing implies that not management of supplies but demand of customer should trigger and influence the production processes. Therefore, logistics gets a new focus on optimization of the manufacturing process in a very dynamic environment. Finally, though there are many solutions and techniques for local optimization (e.g. planning and scheduling systems, inventory management systems, market trading optimization systems), usually these decisions do not guarantee the overall business optimization at the global level because of the conflicts between the local goals.

The SCM problem can be defined as the management of relationships across a supply chain to capture the synergy of intra- and inter-company business processes with the aim of optimizing the overall business process of the enterprise (e.g. on-time delivery, quality assurance, and cost minimization). The simple integration of the traditional techniques is not enough to assure global optimization due to the inherent complexity of the problem. In this way, conceptualization of SCM problem is a large Multi-Agent System (MAS) where:

Figure 1. A schematic diagram of a retail supply chain