Chapter 7
A Memetic Algorithm for Integrated Production Distribution Problem in a Supply Chain

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ABSTRACT

Supply chain is a complex system in which most of the activities are inter-related, and changes in one of these activities can affect the performance of the other processes. Thus, integrated management strategies in a supply chain can yield considerable advantages throughout the system as supply chain members and customers become more integrated. In this study, a memetic algorithm is proposed to solve the integrated production-distribution problem. The objective of the problem is to find optimal production quantity, customer delivery quantity, and schedule to minimize the total system cost, which is composed of production setup cost and variable production cost, inventory holding costs, and distribution cost. The effectiveness of the proposed algorithm is tested on the existing data sets. According to test results, the proposed algorithm is a very effective method to solve integrated production-distribution problems. To assess to benefits and applicability of the method on the real-life problems, a case study is conducted in a Turkish water manufacturing company.

INTRODUCTION

Nowadays, firms need to focus on their supply chain success in order to gain a competitive advantage. Supply chain management is the organization of activities between independent companies, from raw material suppliers to the end customers. The main objective of supply chain management is to decrease the total supply chain costs while increasing the customer service level. Inventory and distribution costs are the major costs in the supply chain. It is important to have a well-managed inventory and distribution system in order to minimize the total supply chain costs.

The success of the supply chain depends on the integration of a network of facilities that procure raw materials, transform them into finished products, and deliver the products to the customers through a distribution system in order to meet customer demands. In a supply chain management process, a manager needs to make strategic decisions regarding the procurement of raw materials, production planning, inventory management, and distribution routing in order to reduce overall supply chain costs. These sub-problems have been extensively investigated but they were mostly dealt with separately both in industrial applications and the literature. However, coordinating these sub-problems can induce evidential cost savings in the supply chain as shown in several studies (Ruokokoski et al., 2010). Kellogg and Frito Lay, which are achieved multi-million cost savings by applying integrated planning systems, can be good real-life examples for the successful applications of integrated systems (Adulyasak et al., 2015). Coordination of the two essential planning stages of supply chain (production and distribution), which gets easier with rapid development in communication and information technology, offers an opportunity to reduce firms' operating costs (Thomas & Griffin, 1996; Bank et al., 2020).

Firms can manage their production and distribution operations independently when they have sufficient inventory in their systems. The reason is that inventory can protect the production and distribution systems against unexpected fluctuations in supply and demand. By contrast, high inventory levels negatively affect holding costs and lead times along the supply chain. In today's competitive environment, companies need to provide products/services faster and cheaper than their competitors and need to adequately meet the high customer expectations in order to gain a competitive advantage. Therefore, companies aim to reduce inventory levels and shorten delivery times across the supply chain. Companies that intend to reduce inventory levels need to maintain closer linkages between production and distribution functions in order to ensure sustainable operations through the supply chain. Eventually, companies can obtain cost savings and improve customer service levels by optimizing production and distribution operations in an integrated manner (Shimci-Levi et al. 2004).

The integration of production-distribution operations can yield considerable advantages throughout the supply chain. Recenlty, vendor managed inventory (VMI)

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