Chapter 6.9
Multi-Echelon Supply Chain Modeling With Dynamic Continuous Review Inventory Policy

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ABSTRACT

In this chapter, an integrated procurement, production and distribution supply chain model is developed in fuzzy environment and performance vector of the supply chain is determined by solving strategic model and tactical model iteratively. Mixed integer programming model is formulated through fuzzy goal programming approach in strategic level. In the tactical level, dynamic continuous review inventory policy for controlling of raw material inventory at supplier echelon, finished products at plant echelon and distribution center echelons is assumed. The inventory models are solved by considering the interdependency of economic order quantity and reorder point. The supply chain model, which is developed in fuzzy environment, finds compromise solution with multiple, vague and in-compatible objectives. Fuzzy goal programming techniques provide feasible solutions with flexible model formulation in decision-making problems, which involve human judgments in decision-making. Need for supply chin modeling with dynamic continuous review policy in fuzzy environment and the existing literature are outlined in Introduction. Fuzzy supply chain modeling with dynamic continuous review policy for controlling of the raw materials, finished products at plant and distribution center echelons is described in Fuzzy supply chain modeling section. Flow chart of the methodology is explained in Solution Methodology section. The proposed model is illustrated through a numerical example. Supply chain cost, Volume flexibility and unit costs are determined and presented in Results and Discussion section. Importance of the methodology and future scope is made in Conclusion section. This model finds application in the industries involving continuous production like oil and natural gas, steel manufacturing industries etc.

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INTRODUCTION

A supply chain consists of suppliers, manufacturers who convert raw materials into finished products and distribution-centers, from which finished products are distributed to customer zones. Hence, the inventory appears in the supply chain in the form of raw material inventory, work-in-process inventory and finished product inventory. Inventory control strategies must take into account the interactions of the various echelons namely, suppliers, plants, distribution-centers and customer zones in the supply chain to reduce total supply chain cost and improve customer service levels. An inventory replenishment policy consists of decisions regarding when to order and how much to order. These decisions determine the cycle inventory and safety inventories along with customer service levels. Two replenishment policies are often used are continuous review and periodic review replenishment policies. These policies may have impact on the supply chain cost, flexibility, and customer service levels.

Robinson et al., (1993) designed an integrated distribution system for a two-echelon, un-capacitated distribution location problem as a mixed integer programming problem and illustrated with a case study. Pyke et al., (1994) developed a supply chain model by considering multiple products, with independent demand and the expedited batches, and optimized the total cost of supply chain subjected to the service levels for all products. Petrovic et al., (1998) developed a simulation model of supply chain in uncertain environment. Beamon (1998) presented an overview and evaluation of the performance measures used in supply chain models. Sabri et al., (2000) developed a supply chain model that facilitates simultaneous strategic and operational planning using an interactive method. Vorst et al., (2000) formulated supply chains for agriculture products through linear programming approach. Chen et al., (2000) adopted fuzzy approach to develop supply chain model. Lee et., al., (2002) presented a hybrid methodology, that combines the analytic and simulation models for an integrated production distribution model in supply chain. Han-Lin Li (2002) proposed a method of building a supply chain management system that determines production plan purchasing plan, inventory plan and distribution plan by minimizing the total cost. Chen et al., (2003) formulated multi-objective mixed integer non-linear programming problem and adopted two-phase fuzzy decision making method to solve the supply chain model involving manufacturing plants, distribution centers and retailers. Cohen and Lee (2004) developed a model of material requirement policy for every shop in a production system using cost based stochastic sub-models namely material control sub-model, production sub-model and distribution sub-model to predict the performance of alternative manufacturing strategies. Chen and Lee (2004) presented a two-phased fuzzy optimization approach to maximize total profit subjected to satisfaction of seller and buyer's preference on sales prices.

Eskigun et al., (2005) modeled supply chain network design and proposed Lagrangian heuristic method to obtain strategic decision of the model. Amiri (2006) developed a mixed integer-programming model and proposed heuristic procedure for a supply chain network design. Manzini et al. (2007) defined a conceptual framework for the development of new modeling approaches for the production and distribution logistic system design problem with three levels of decisions in a supply chain, namely strategic, tactical and operational levels. Liang (2007) developed fuzzy goal programming approach for solving the integrated Production Transportation Planning Decision (PTPD) problems with fuzzy multiple goals in uncertain environments. Trevor et al. (2008) presented a framework for an integrated optimization model of supply chain functions in a multi-plant, multi-product, multi-customer supply chain with deterministic demands.

Cheng et al., (2008) discussed mmultiple supplier and multi-product inventory model,