Chapter 8
Analysis of Some Stochastic Inventory System in Supply Chain

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ABSTRACT

In this chapter we consider a three echelon inventory control system which is modeled as a warehouse, single distribute and one retailer system handling a single product. A finished product is supplied from warehouse to distribution center which adopts one-for-one replenishment policy. The replenishment of items in terms of packets from warehouse to distribution center with exponential lead time having parameter \( \mu_1 \). Then the product is supplied from distribution center to retailer who adopts \((s, S)\) policy. Supply to the retailer in packets of \( Q (= S - s) \) items is administrated with exponential lead time having parameter \( \mu_0 \). The demand at retailer node follows a Poisson with mean \( \lambda \). The steady state probability distribution of system states and the measures of system performance in the steady state are obtained explicitly. The Cost function is computed by using numerical searching algorithms, the optimal reorder points are obtained for various input parameters. Sensitivity analysis are discussed for various cost parameter such as holding cost, setup cost etc.

1. INTRODUCTION

In this chapter, we study some stochastic inventory control problems in Supply Chain Management System (SCMS). Our main objectives are to find steady state probabilities of the inventory levels and the optimum values of the decision variables that minimize the total expected cost in the SCMS. Most of the results are illustrated with numerical examples and sensitivity analysis.

The major focus of our work is on operational decisions such as inventory control and distribution management in Supply Chain (SC). The motivation of our research lies with real life serially connected locations and the need of optimal policies for its efficient maintenance. Even though the numbers of models analyzed within the preview of Supply Chain are limited, we studied the flow of goods through
the Supply Chain which are both perishable and non-perishable. Most of our models assume Poisson demand, exponential lead times and exponential life time. Since the demand is highly fluctuating the position inventory can be considered as a random process, to deal with real life problems we consider Supply Chain with random type demands and lead times only in this work.

1.1. The Importance of Supply Chain Management

Basically, the world is one of the biggest Supply Chain. The Supply Chain Management (SCM) touches major issues, including the rapid growth of multinational corporations and strategic partnerships; global expansion and sourcing; fluctuating gas prices and environmental concerns. Each of these issues dramatically affects corporate strategy and bottom line. Because of these emerging trends, Supply Chain management is the most critical business discipline in the world today.

A Supply Chain may be defined as an integrated process wherein a number of various business entities suppliers, distributors and retailers work together in an effort to (i) acquire raw materials (ii) process them and then produce valuable products and (iii) transport these final product to retailers.

1.2. Inventory Management System

Inventory decision plays the important role in each stage of supply chain management. The process and delivery of goods through this network needs efficient communication and transportation system. The supply chain is traditionally characterized by a forward flow of materials and products and backward flow of information and money.

Keeping an inventory (stock of goods) for future sale or use is common in business. In order to meet demand on time, companies must keep on hand a stock of goods that is awaiting sale. The purpose of inventory theory is to determine rules that management can use to minimize the costs associated with maintaining inventory and meeting customer demand.

Inventories represent about one-third of all assets of a typical company in the United States, with the total value of capital tied up in inventories around $1.1 trillion in 1992, representing over 20% of the GNP (Economic Report of the President -1993). Inventory is studied in order to help companies save large amounts of money. Inventory models answer two major questions: (1) when should an order be placed for a product? (2) How large should each order be? The answer to these questions is collectively called an inventory policy. Companies save money by formulating mathematical models describing the inventory system and then proceeding to derive an optimal inventory policy.

The inventory models have a wide range of applications in the decision making of governments, military organizations, industries, hospitals, banks, educational institutions, etc. Study and research in this fast growing field of Applied Mathematics taking models from practical situations will contribute significantly to the progress and development of human society.

A complete review was provided by Benita M. Beamon (1998). However, there has been increasing attention placed on performance, design and analysis of the supply chain as a whole. HP’s (Hawlett Packard) Strategic Planning and Modeling (SPaM) group initiated this kind of research in 1977. From practical stand point, the supply chain concept arose from a number of changes in the manufacturing environment, including the rising costs of manufacturing, the shrinking resources of manufacturing bases, shortened product life cycles, the leveling of planning field within manufacturing, inventory driven costs