Analysis of Some Lead-Time Reduction Strategies in Two-Echelon Supply Chain Systems

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Abstract

This thesis explores some important issues in the two-echelon supply chain management (SCM) to fill the gap in the literature work, covering production, replenishment, and lead-time decision.

The thesis includes of eight chapters.

The thesis starts with **Chapter 1:** Being an introductory chapter, it provides a brief overview about SCM. Various terminologies and basic concepts of SCM relevant to the thesis are also provided. The chapter ends by providing the problem statement and outline of the thesis.

In **Chapter 2** a brief background of the literature used in this study is presented.

In **Chapter 3** a joint economic lot size (JELS) model is developed to enhance the greening efforts of a product that flows along a two-level supply chain (supplier-retailer). Impact of both selling price and greening effort level on demand function has been considered. It is assumed that every individual lot shipped to the retailer carries some random defective items. Hence, each lot goes through an error-free sub-lot sampled inspection process to remove the defective items. The profit function is developed under three decision making scenarios: centralized, decentralized, and coordinated. Coordination is made based on a trade-credit scheme. From the results, it is clear that the coordination among the supply chain members has resulted in an improvement in the level of the greening of the product and profits of the supply chain.

In **Chapter 4** we explore a continuous-review vendor-buyer supply chain (SC) model wherein the lead-time (taken as replenished) is considered as a factor affected upon by the time stamp required for setup and production followed by transportation. Here, the production time indicates the interaction between the lot-size and lead-time. Assuming the existence of an opportunity with the buyer of reducing the replenishment lead-time. The buyer receives normally distributed stochastic lead-time demands from its customers. Due to the stochastic nature of lead-time demand, shortages may arise at the buyer's side which is fully backlogged. We presume imperfection production at the vendor's end, which leads to the generation of a certain ratio/percentage of defective products, which results in additional warranty costs for the vendor. This study intends to uncover the best policy that minimizes the system's total expected cost. A solution algorithm with some lemmas is provided which helped in finding the optimal solution and to prove the uniqueness of the solutions. Findings demonstrate that a reduction in lead-time can effectively lower safety stock as well as the total cost.

Chapter 5 studies an integrated vendor-buyer model with shortages under order size and production rate dependent lead time. Shortages are partially backlogged and the backlogging rate depends on the length of the lead time. It is assumed that the replenishment lead time can be reduced by changing the regular production rate of the vendor at the risk of paying additional cost. The proposed model is formulated to obtain the net present value (NPV) of the expected total cost of the integrated system. An increasing value of demand deviation increases the chance of stock-out probability. Therefore, the present value of the expected total cost increases for all three scenarios. It is observed that the order quantity is insensitive to productivity improvement cost for low demand deviation. This is due to the fact that for low demand deviation, there is no need to invest in order to improve the productivity of the system. However, for high and medium demand deviations, order quantities are sensitive to productivity improvement cost and a step-wise decrease in order quantity. Therefore, for the case of medium and high demand deviations, it is beneficial to decrease the replenishment lead time by ordering less quantity

Chapter 6 includes the concept of deterministic lead time in a single-manufacturer single-retailer integrated SC system with controllable backorder rate and trade-credit financing. Here the replenishment lead time is decomposed into various components and investment is made to reduce the components. First, the lead time demand at the retailer is assumed to be normally distributed and then it is considered distribution-free. Shortages are partially backlogged and the backlogging rate depends on the lead time which can be reduced by some additional cost. The manufacturer offers the retailer a credit period which is less than the reorder interval. Min-max approach is adopted to solve the model when lead time demand is distribution-free. It is observed that a higher value of credit period increases the retailer's order quantity. Safety factor and reorder point both tend to decrease as credit period increases. It is seen that increase in the value of lead time demand deviation decreases the backorder rate.

Further, in **Chapter 7** we extended previous model for the case of variable lead time under a service level constraint. The buyer is faced with price and effort dependent stochastic lead time demand. Here we consider the lead-time as an added control parameter which can be crashed through some addition cost which is a negative exponential function of the lead time. We propose both centralized and decentralized approaches considering that the distribution of the lead time demand is unknown and adopt distribution free approach to solve those models. Coordination is made based on price discount contract. It is observed that with an increase in lead-time demand deviation, the order quantity also increases and number of shipment decreases.

In **Chapter 8**, an outline of overall conclusion of the works done in this doctoral study is given and some future research scopes are referred.

M Maiti
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Professor
Department of Mathematics
Jadavpur University
Kolkata-700032

05/05/2022

Professor
Department of Mathematics
Jadavpur University
Kolkata-700032

Sumon Sarkar
05/05/2022