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Credit financing in a two-warehouse environment for deteriorating items with price-sensitive demand and fully backlogged shortages

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ABSTRACT

In the current global market, organizations use many promotional tools in order to increase their sales. One such tool is permissible delay in payments, i.e., the buyer does not have to pay for the goods purchased immediately rather can defer the payment for a prescribed period given by the supplier. This phenomenon motivates the retailer/buyer to order a large inventory lot so as to take full benefit of credit period. But the well decorated show-room (OW) with modern facilities has a limited storage capacity. Thus the retailer has to hire a rented warehouse to store the excess units. In this scenario, retailer usually adopts two types of dispatch policy: FIFO & LIFO, depending upon the situation, e.g., nature of items/deteriorating items, location of warehouse. Further in order to survive in the market, the retailer dynamically adjusts the prices of the goods to boost the demand and enhance the revenues.

In the light of these facts, this paper develops an inventory model for deteriorating items with price-sensitive demand under permissible delay in payment in a two warehouse environment. Shortages are allowed and fully backlogged. The objective of this study is to find the optimal inventory and pricing policies so as to maximize the total average profit. Further, the different trade credit scenario has been exhibited with the help of a numerical example. A comprehensive sensitivity analysis has also been carried out to advocate the implication of FIFO and LIFO dispatch policy.

1. Introduction

In today's competitive market environment, with the intention to grow and progress in business, the supplier offers the retailer a period called delay period or trade credit period, to pay the cost of the purchased material. During this period the retailer can sell the goods and earn interest on them. An interest is charged if the retailer is unable to settle the account by the end of the credit period. Thus it makes economic sense for the retailer to delay the settlement of the replenishment account up to the end of the delay period allowed by the supplier. According to the existing literature, the foremost Economic Order Quantity (EOQ) under the condition of a permissible delay in payment with deterministic demand, without shortages was considered by Haley and Higgins [1]. Then Goyal [2] developed an economic order quantity (EOQ) model under the conditions of permissible delay in payments.

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Moreover, the phenomenon of deterioration cannot be ignored in inventory analysis. Thus, Aggarwal and Jaggi [3] extended the Goyal's model (EOQ model under permissible delay in payments) for deteriorating items. Jamal et al. [4] further generalized the model by allowing the completely backlogged shortages. There after, a lot of works has been done by several researches. In this connection, the works of Huang [5], Sana and Chaudhari [6], Jaggi and Mittal [7] and others are worth-mentioning.

However, in their works, they have developed the model for a single warehouse under the assumption that the available warehouse has unlimited capacity. But now a days the retail outlets (i.e., own warehouse/display area) are highly equipped with modern lightning and electronic arrangements, and also provide enough space for the customers to move around. So, when an enterprise or a retailer purchases a large quantity of goods at a time, these goods can not be stored in the existing warehouse (i.e., OW) with limited capacity. Hence for storing the excess goods, one or more warehouse (i.e., RW), is hired on rental basis. But, in general, it is observed that RW costs more than that of OW, as it provides good storage amenities.

Further, to reduce the holding costs, the organization first uses the RW's goods to satisfy the demand. This phenomenon is called Last-In-First-Out (LIFO) approach, since the organization stores the goods in RW last (after filling the OW) and uses it first (prior to the goods of OW). However due to changing market trends, more emphasis is given on customer satisfaction, so the organizations may also adopt First-In-First-Out (FIFO) approach, i.e., first sells the goods of OW that are stored first. This approach ensures that fresh products are sold which yields greater customer satisfaction and helps to boost the sales and increase the value of the organization in the long run. Thus, in such a scenario, the organization may prefer to use FIFO or LIFO dispatching policy depending upon the nature of items, current market trends, location of the warehouses etc.

In the literature, a lot of work has been done on two-warehouse inventory system. An early discussion was considered by Hartely [8] and Sarma [9]. Continuing the research ahead, a number of research papers in this interesting area has been published by several researches over the last few decades. In this connection, one may refer to the works of Lee [10], Niu and Xie [11], Rong et al. [12], Dey et al. [13], Hsieh et al. [14], Jaggi et al. [15] and others. Recently, Jaggi and Verma [16] revisited the Sarma's [9] LIFO model for deteriorating items in a two-warehouse environment under FIFO dispatch policy, in which shortages are fully backlogged. Jaggi et al. [17] extended the previous work by incorporating the partial backlogging rate and explored the application of FIFO and LIFO dispatching policies in different scenarios in the model.

The above mentioned models did not assimilate the concept of permissible delay in payments in a two-warehouse environment. However, Chung and Huang [18] and Liang and Zhou [19] investigated a two-warehouse inventory model for deteriorating items under conditionally permissible delay in payments.

Further, researchers have paid less attention for the price-sensitive demand in two-warehouse inventory model. But in reality the demand of an item get influenced by its selling price. For example, in the retail industry, organizations may dynamically adjust their prices in order to boost demand and enhance revenues. In this area, Hwang and Shinn [20] developed the inventory policy for exponentially deteriorating items with price-dependent demand under the condition of permissible delay in payment and Abad and Jaggi [21] presents a joint approach for setting unit price and the length of the credit period for a seller when end demand is price sensitive.

Considering all the above discussed aspects, an attempt is made to present a two warehouse inventory model from a retailer's point of view when supplier offers a permissible delay in payments and demand is price- sensitive. Shortages are allowed and fully backlogged. Additionally in the model formulation, interest earned on shortages has been considered, which so far has not thought of by the researchers. The basic objective of this work is to determine the optimal inventory and pricing strategies which maximizes the total average profit. Further, analysis of FIFO and LIFO dispatch policies has been carried out with the help of a numerical example, which would help the organization to take the best possible decision according to the existing market trend. A comprehensive sensitivity analysis has also been performed to explore important managerial insights.

2. Assumption and notations

The following assumptions and notations have been used in the entire paper.

2.1. Assumptions

(i) The demand rate $D(p)$, is assumed to be dependent on the selling price and of form, $D(p) = kp^{-e}$ where k and e are positive constants.
(ii) Replenishment rate is infinite.
(iii) The inventory planning horizon is infinite and the inventory system involves only one item.
(iv) Lead-time is negligible.
(v) Deterioration is considered only after the inventory stored in the warehouse. There is neither repair nor replacement of the deteriorated units during the inventory cycle.
(vi) Shortages are allowed and fully backlogged.
(vii) The OW has a fixed capacity of W units; the RW has unlimited capacity.
(viii) The units in RW are stored only when the capacity of OW has been utilized completely.
(ix) Supplier offers a permissible delay period to the retailer to settle the accounts.