Chapter 25
A Time Dependent Order Level Inventory Model for Beta Deterioration in Two Warehouse Systems

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ABSTRACT

An inventory problem for a deteriorating item having two separate warehouses is developed under time value of money, whereby one is an own warehouse (OW) of finite dimension(s) and the other is rented warehouse (RW) of infinite dimension(s). Deterioration rate of items in the two warehouses may be different, which is time dependent and deterioration is in the mean beta distribution form. In this study, shortages and complete backlogging have been considered as the other items, whereby the demand rate of items is linear with time in OW and the same is linear with price in case of RW. Also, the stocks of RW transported to OW in continuous release pattern.

INTRODUCTION

In the busy markets (like super market, municipality market etc.), the storage area of items is limited. When an attractive price discount for bulk purchase is available or the cost of procuring goods is higher than the other inventory related cost or demand of items is very high or there are some problems in frequent procurement, management decides to purchase a large amount of items at a time. These items cannot be accommodated in the existing warehouse (viz. the Own Warehouse, OW) located at busy market place.

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When the acquisition costs are higher than the inventory costs (including holding cost and deterioration cost) or when suppliers provide price discount for bulk purchase, the management may purchase more goods than that can be stored in its own warehouse (OW). Therefore, these excess quantities are stored in a rented warehouse (RW). Usually, the inventory costs for RW are higher than those for OW. As a result, the firm stores goods in OW before it does in RW, and clears stocks in RW before it does it in OW. This is done to reduce the inventory costs. Literatures in this direction include Benkherouf, Bhunia and Maiti, Goswami and Chaudhuri, Pakkala and Achary, Sarma, and among others. In this situation, for storing the excess items, one additional warehouse (viz. rented warehouse, RW) is hired on rental basis. We assume that the rent (i.e. holding cost for the items) in RW is greater than OW and hence the items are stored first in OW and only the excess stock is shifted to the RW, which are again occupied back with transporting the stocks from RW to OW in a continuous release pattern for reducing the holding cost. This is the real background of the two-warehouse inventory problem. There are some common assumptions in the two-warehouse inventory problem. It is often believed that the storage capability of the OW is limited but the storage capability of the rented warehouse (RW) is unlimited. So compared with the OW, the inventory cost in RW is higher but the deterioration rate is lower. According to these assumptions, it is easy for us to understand that in order to reduce the inventory cost; it will be a good choice to consume the items in the RW first and store items in OW before RW (last in first out policy, LIFO).

In this paper, an order level inventory model for deteriorating items using two-warehouses is developed. A rented warehouse is used to store the excess units over the fixed capacity of the own warehouse. The demand rate of two warehouses is different. Shortages are allowed.

Many authors have considered inventory model for deteriorating items during the last decade. Most of the classical inventory models discussed in the literature deals with the situation of a single warehouse. But, in practice, for holding very large inventories several warehouses would be required. Sarma developed a model for a single deteriorating item where both the demand rate and the deterioration rate are assumed to be constant over a fixed scheduling period. T.P.M. Pakkala, K.K. Achary developed a model with discrete time inventory model for deteriorating items with two- warehouses. S. Kar. A.K. Bhunia, M. Maiti, developed a model with deterministic inventory model with two levels of storage, a linear trend in demand and a fixed time horizon.

Pakkla and Achary developed a two-warehouse probabilistic order level inventory model for deteriorating items. Pakkla and Achary developed a deterministic inventory model for deteriorating items with two warehouses and finite replenishment rate. These models assumed time as a continuous variable. Pakkla and Achary also developed a discrete-in-time model for deteriorating items with two warehouses. Ishii and Nose investigated the optimal ordering policies for a perishable product with different types of customers' priority, different selling prices specified and the OW capacity constraint. Benkherouf extended Sarma's model and relax the assumptions of fixed cycle length and specified quantity to be stocked in OW. He found the optimal schedule that minimizes the total cost per unit time in a cycle for an arbitrary demand rate function where the cycles are assumed to be a regenerative process. Bhunia and Maity analyzed a deterministic inventory model with different levels of item deterioration in both warehouses. Zhou developed a deterministic model with multiple warehouses possessing limited storage capacity. The demand rate is a function of time. The model allows shortage in OW. Yang considered a two-warehouse inventory models for constant deteriorating items with constant demand rate and complete shortages under inflation. Geetha, Uthayakumar considered Economic design of an inventory policy for non-instantaneous deteriorating items under permissible delay in payments. Shah, Wee developed a lot size inventory model for the Weibull distributed deterioration rate with discounted selling price and