An Optimal Inventory Policy for Items Having Constant Demand and Constant Deterioration Rate with Trade Credit

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ABSTRACT

In most of the classical inventory models the demand is considered as constant. In this paper the model has been framed to study the items whose demand and deterioration both are constant. The authors developed a model to determine an optimal order quantity by using calculus technique of maxima and minima. Thus, it helps a retailer to decide its optimal ordering quantity under the constraints of constant deterioration rate and constant pattern of demand.

Keywords: *Constant Demand, Constant Deterioration Rate, Credit Period, Maxima, Minima, Optimal Payment Time*

INTRODUCTION

In general practice, it is assumed that the buyer must pay for the items purchased as soon as the items are received. Suppliers are known to offer their customers, a fixed period of time and do not charge any interest of this period. However, a higher interest is charged if the payment is not settled by the end of credit period. Usually interest is not charged for the outstanding amount if it is paid within the permissible delay period. On the other hand, if the payment is not paid within the permissible delay period the interest is charged on the outstanding amount under the previously agreed terms and conditions. The permissible delay in payments reduces the buyer's cost of holding stock, because it reduces the amount of capital invested in stock for the duration of permissible period.

The concept of permissible delay was first introduced by Goyal (1985). Aggarwal and Jaggi (1995) then extended Goyal's model for deteriorating items. Further Jamal et al. (1997) generalized the model to allow for shortages and deterioration. Chandra and Bahner (1985) also developed model under inflation and time value of money. Chang et al. (1999) presented model for the situation where the demand rate is a time-continuous function and item deterio-

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rates at a constant rate with partial backlogging. Teng (2002) considered the EOQ model under permissible delay in payment which is further extended by Ken. Chung and Huang (2003) for limited storage capacity. Goyal et al. (2005) developed the optimal pricing and ordering policies under permissible delay in payments. Recently, Chang and Dye (2001) extended the model by Jamal et al. to allow for not only a varying deterioration rate of time but also the backlogging rate to be inversely proportional to the waiting time. Chang et al. (2003) extended Teng's model and established an EOQ model for deteriorating items in which the supplier provides a permissible delay to the purchaser, if the order quantity is greater than or equal to a predetermined quantity. Sarbjit and Shivraj (2009) developed an EOQ having linear demand rate under permissible delay in payments with variable rate of deterioration. Ghare and Schrader (1963) were the first to use the concept of deterioration followed by Covert and Philip (1974) who formulated a model with variable deterioration rate with two parameters Weibull distribution, which was further extended by Shah (1977). Buzacott, (1975) and Bierman and Thomas (1977) investigated the inventory models with inflation followed by Misra (1979). Liao et al. (2000) developed an inventory model for stock-depend demand rate when a delay in payment is permissible.

In this paper, we establish a model for a retailer to determine its optimal price and optimal time. In the next section mathematical formulations is mentioned. Cost function has been mentioned followed by determination of optimal solution. At last concluding remarks are given.

MATHEMATICAL FORMULATION

In this model, constant demand is considered with constant deterioration rate. Depletion of the inventory occurs due to demand as well as due to deterioration which occurs only when there is inventory during the period [0, T]. The level of inventory I(t) gradually decreases mainly due to meet demands and partially due to deterioration. The variation of inventory with respect to time can be described by the following differential equation:

$$\frac{dI(t)}{dt} + \theta\, I(t) = -D,\ 0 \le t \le T \tag{1}$$

with I(0) = Q (initial inventory level)

The solution of (1) is given by

$$I(t) = Q\, e^{-\theta t} - \frac{D}{\theta}\,(1 - e^{-\theta t}) \tag{2}$$

It is obvious that at t = T, i.e., at the end of cycle period I(T) = 0. So from equation (2), we obtain

$$Q = \frac{D}{\theta}\,(e^{\theta T} - 1) \tag{3}$$

Substituting (3) in (2), we get

$$I(t) = \frac{D}{\theta}\left\{e^{,(T-t)} - 1\right\},\ 0 \le t \le T \tag{4}$$

The total demand during cycle period T is $\int_0^T D\, dt$. Thus the amount of items deteriorates during one cycle is given by:

$$D_T = Q - \int_0^T D\, dt = \frac{D}{\theta}\left(e^{\theta T} - 1\right) - DT \tag{5}$$

EVALUATION OF COST FUNCTION

(a) For most of the inventory systems ordering cost for items is fixed at 'A' rupees/order

(b) The cost of deterioration is given by:

$$C_D = cD_T = cD\left\{\frac{e^{\theta T} - 1}{\theta} - T\right\} \tag{6}$$

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