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AN INVENTORY MODEL FOR DETERIORATING ITEMS WHEN SUPPLIER OFFERS PERMISSIBLE DELAY IN PAYMENTS FOR FINITE PLANNING HORIZON UNDER INFLATION

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ABSTRACT

In this paper a deterministic inventory model for perishable items with constant demand rate and deterioration is developed. In this study a supplier-purchaser case is studied in which supplier facilitates the purchaser with a permissible delay in payment if the purchaser orders a big amount of quantity. Model is considered for finite planning horizon under inflationary conditions. The study discusses the cost analysis of inventory system under the parameters of time value of money, deterioration, constant demand and inflation. The results are illustrated with the help of numerical examples. The sensitivity of the solution with the change of the values of the parameters associated with the model is also discussed.

Keywords: Inventory, Demand, Deterioration, Time Value Of Money, Inflation, Finite Planning Horizon

1. INTRODUCTION

Normally, the payment for an order is made by the retailer to the supplier immediately just after the receipt of the consignment. Now-a-days, due to the stiff competition in the market, to attract more customers, a credit period is offered by the supplier to the retailer. Moreover, for the speedy movement of capital, a wholesaler tries to maximize his/her market through several means. For this, very often some concessions in terms of unit price, credit period, etc., are offered to the retailers against immediate full/part payment. To avail these benefits, a retailer is tempted to cash down a part of the payment immediately even making a loan from the money lending source which charges interest against this loan. Now the retailer is in dilemma for optimal procurement and also for the amount for immediate part payment. Here an amount, borrowed from the money lending source as a loan with interest, is paid to the wholesaler at the beginning on receipt of goods. In return, the wholesaler/supplier offers a relaxed credit period as permissible delay in payment of rest amount and a reduced unit purchasing price depending on the amount of immediate part payment. Inflation also plays an important role for the optimal order policy and influences the demand of certain products. As inflation increases, the value of money goes down and erodes the future worth of saving and forces one for more current spending. Usually, these spending are on peripherals and luxury items that give rise to demand of these items. As a result, the effect of inflation and time value of the money cannot be ignored for determining the optimal inventory policy. In the present paper, an inventory control system in which the delay-payment is allowed by the wholesaler for an item over a finite planning horizon. These models are illustrated with numerical examples. Finally, the sensitivity analyses of deterioration rate, holding cost, ordering cost, credit period and inflation rate with respect to some parameters are carried out and the results are presented. In past, many researchers have discussed the inventory related problems. First, Goyal [1] presented an EOQ model under the conditions of permissible delay in payments. Since then, lots of literature is available in this area of study. The interesting papers related to such studies are Chu et al. [2], Chung [3], Jamal et al. [4], Sarker et al. [5] and others. Shah [6] considered the time value of money along with the trade credit for a finite time horizon inventory model with deteriorating items. Effect of inflation and time value of money is also well established in inventory problems. Initially, Buzacott [7] used the inflation subject to different types of pricing policies. Then consequently in the subsequent years, Moon and Lee [8], Chen [9], Dey et al. [10], Padmanavan and Vrat [11], Hariga and Ben-daya [12], and others worked in this area. Jaggi et al. [13] developed an inventory model with shortages, in which units are deteriorating at constant rate and demand rate is increasing exponentially due to inflation over a finite planning horizon using discount cash flow approach. Most recently, Chen and Kang [14] and Huang [15] presented integrated inventory models considering permissible delay in payment and variant pricing strategy for determining the optimal replenishment time interval and replenishment frequency. Tripathi et al. [16] developed a cash flow oriented EOQ model under permissible delay in payments for non-deteriorating items and time-dependent demand rate under inflation and time discounting. Liao et al. [17], Chung and Liao [18] dealt with the problem of determining the EOQ for exponentially deteriorating items under permissible delay in payment depending on the ordered quantity and developed an efficient solution-finding procedure to determine the retailer's optimal ordering policy. Chang [19] extended Chung and Liao's model by taking into account the inflation and finite time horizon with large quantity of purchase orders. Yang [20] presented an inventory model with different pricing policies. Singh et al. [21] proposed a two warehouse model under inflation with large quantity of purchase orders. Chung and Huang [22] studied ordering policy with permissible delay in payments to show the convexity of total annual variable cost function. Barron et al. [23] demonstrated optimal order size to take advantage of a one-time discount offer with allowable backorders when the supplier offers a temporary fixed percentage discount and has specified a minimum quantity of additional units to purchase. Recently, Guria et al. [24] proposed a pricing model for petrol/diesel and determined the optimal ordering policy for an existing petrol/diesel retailing station under permissible delay in payment with and without fully backlogged shortages. Several authors like Panda and Maiti [25] investigated the inventory models of this type of item. Joint price and lot size determination problems for deteriorating products were studied by Kim et al. [26]. Abad [27] investigated the inventory models of this type of item. Jaggi et al. [28,29], Liang and Zhou [30] solved two warehouse inventory models for deteriorating items with price dependent demand. Dey et al. [31] developed a two-storage inventory model with shortages and lead time in which units are non-deteriorating and demand is dynamic under inflation and time-value-money. It is a fact that the demand of an item is influenced by the selling price of that item i.e. whenever the selling price of an item increases, the demand of that decreases and vice-verse. Maiti et al. [32] introduced the concept of advanced payment for determining the optimal ordering policy under stochastic lead-time and price dependent demand condition. Though several articles are available in the area of the inventory models with permissible delay in payment, there are some lacunas in the above mentioned literature. These are:_ Though the part payment at the time of purchase is now-a-days a part of the business from both ends – i.e., to bring immediate cash to the wholesaler and to give some price and payment concessions to the retailer, this has been ignored by the researchers. _ Most of the above inventory models are developed for infinite planning horizon with the common assumptions that lifetime of the product is infinite. Due to fluctuating world economy, cost of raw materials as well as production cost of a product changes rapidly. Also, with time, fashion and liking of the customers change and the introduction of multinationals leads to change in product specifications with new features. So, in reality lifetime of a product is finite and uncertain. Very few articles (cf. [33–36] etc.) are there incorporating this assumption. A. Guria et al. / Applied Mathematical Modeling 37 (2013) 240–257 241_ As mentioned above, inflation has a major effect on the demand of the goods, especially for fashionable goods for middle and higher income groups. Formulation of inventory models with the above conjecture allowing part payment and trade credit will be a realistic one as inflation, at present, is rampant throughout the world. Correcting the above short comings, in this paper, an attempt has been made to formulate and to solve a real-life inventory model with inflation and constant demand under finite planning horizon allowing trade credit. In this paper we analyze a deterministic inventory model assuming that demand is constant. The organization of the paper is as follows: In section 2, we introduce the notation used throughout the paper and the basic assumptions of the inventory system. In section 3, we develop the mathematical model that describes the evolution of the inventory system and a procedure to solve the inventory problem. In section 4, numerical examples are provided to illustrate the solution procedure. In section 5, we present a sensitivity analysis of the inventory policy and in last the conclusion is discussed.

2. ASSUMPTIONS AND NOTATIONS

The following notations are used throughout the paper.

2.1. Notations:

I(t)	:	the instantaneous stock level at time t, $0 \le t \le T$.
D	:	the demand per unit time.
θ	:	Constant rate of deterioration, $0 \le \theta < 1$.
r	:	Constant rate of inflation, $0 \le r < 1$.
c_1	:	Inventory holding cost rate per unit time excluding interest charges.
c_2	:	unit purchasing cost at time zero.
c_3	:	ordering cost i.e. cost per order at time zero.
p	:	unit selling price at time zero.
I_c	:	the interest charged per Rs. per year by the supplier.
I_e	:	the interest earned per Rs. per year.
T	:	Length of each ordering cycle.

Q	:	the order quantity for each ordering cycle.
q	:	the minimum order quantity at which the delay in payments is permitted.
T_q	:	the time interval of q units are depleted to zero.
M	:	the trade credit period.
H	:	the length of planning horizon.

2.2. Assumptions:

1. The inventory system involves only one item.
2. The replenishment rate is infinite and instantaneous.
3. The deterioration rate $\theta (0 \le \theta < 1)$ is constant.
4. There is no replacement or repair of deteriorated units during the period under consideration.
5. Delay in payments is allowed upto M.
6. If order quantity Q<q then the payments have to be made immediately.
7. If order quantity $Q \ge q$ then delay in payments is allowed.
8. The demand D is known and constant.
9. Shortages are not allowed.
10. Planning horizon is finite.

3. MODEL FORMULATION AND DEVELOPMENT

let I(t) be the inventory level at any time t. The inventory is depleted partly to meet the demand and partly for deterioration. The rate of change of inventory can be described by the following differential equations:

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

The solution of differential equation (1), using boundary conditions, $I(0) = Q$ and $I(T) = 0$

$$I(t) = \frac{D}{\theta}\left[e^{\theta(T-t)} - 1\right], \quad 0 \le t \le T \tag{2}$$

and

$$Q = \frac{D}{\theta}\left[e^{\theta T} - 1\right] \tag{3}$$

From this equation, we can obtain the time interval T_q that quantity q is depleted to zero.

$$T_q = \frac{1}{\theta} In\left[\frac{\theta}{D} q + 1\right] \tag{4}$$

Also from (2), Since all time intervals are equal, we have

$$I(t+\alpha T)=\frac{D}{\theta}\left[e^{\theta(T-t)}-1\right], \qquad 0\le t\le T\,, \qquad 0\le \alpha\le n-1 \tag{5}$$

The total cost in the planning horizon H

TC = Ordering Cost + Purchasing cost +Inventory holding cost+ Interest charged-Interest earned (*)

Calculation of variable costs:

Present value of holding cost

$$HC=c_1\sum_{\alpha=0}^{n-1}c_2e^{r\alpha T}\int_0^T I(\alpha T+t)dt$$

$$=\frac{c_1c_2D}{\theta^2}\left(e^{\theta T}-\theta T-1\right)\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{6}$$

Present value of ordering cost

$$=\sum_{t=0}^{n-1}c_3.e^{rtT}$$

$$=c_3\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{7}$$

Present value of purchasing cost

$$=Q\sum_{t=0}^{n-1}c_2.e^{rtT}$$

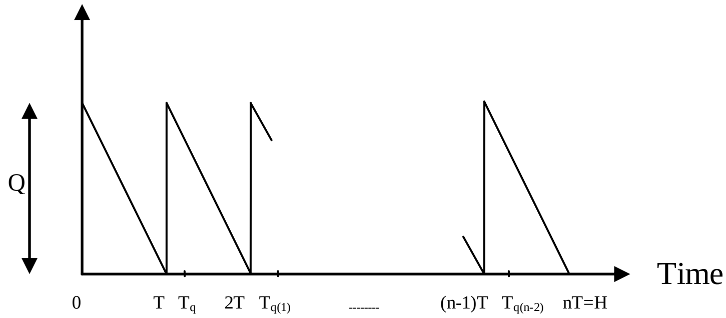
$$=c_2\frac{D}{\theta}\left[e^{\theta T}-1\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{8}$$

Calculations of interest charged and interest earned

To calculate interest charged and interest earned, we have the following four possible cases:

Case 1: $0<T<T_q$

Inventory level



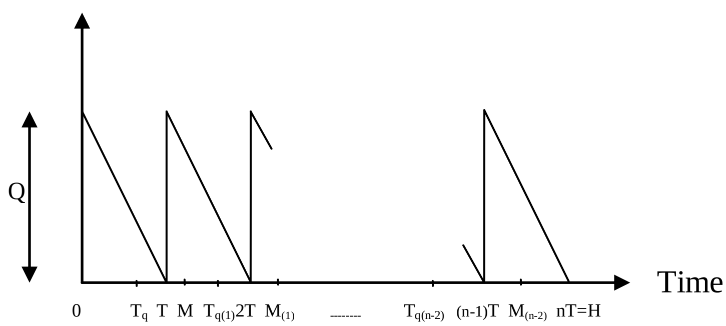
In this case replenishment time is less than the time where minimum order quantity at which the delay in payments is permitted so in this case delay in payments is not permitted. The supplier have to be paid as soon as the buyer receives the items. So the interest charges for all unsold items start in the beginning. Therefore interest payable in whole planning horizon is

$$= I_c \sum_{\alpha=0}^{n-1} c_2 e^{r\alpha T} \int_0^T I(t+\alpha T)dt$$

$$= \frac{I_c c_2 D}{\theta^2}\left(e^{\theta T} - \theta T - 1\right)\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{9}$$

Case 2: $T_q \le T < M$

Inventory level

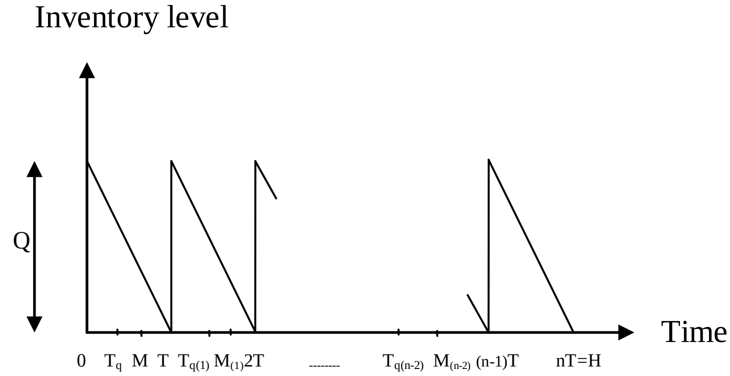


In this case replenishment time is more than the time where minimum order quantity at which the delay in payments is permitted so in this case delay in payments is permitted. So there is no interest charges but interest earned will be there in whole planning horizon is

$$= I_e \sum_{\alpha=0}^{n-1} p e^{r\alpha T}\left[DT(M-T) + \int_0^T Dtdt\right]$$

$$= I_e pD\left(TM - \frac{T^2}{2}\right)\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{10}$$

Case 3: $T_q \le M \le T$



In this case replenishment time is more than or equal to the time where minimum order quantity at which the delay in payments is permitted and trade credit period so in this case delay in payments is permitted and both interest charged and interest earned in whole planning horizon is

The interest charged

$$= I_c \sum_{\alpha=0}^{n-1} c_2 e^{r\alpha T} \int_M^T I(t+\alpha T)dt$$

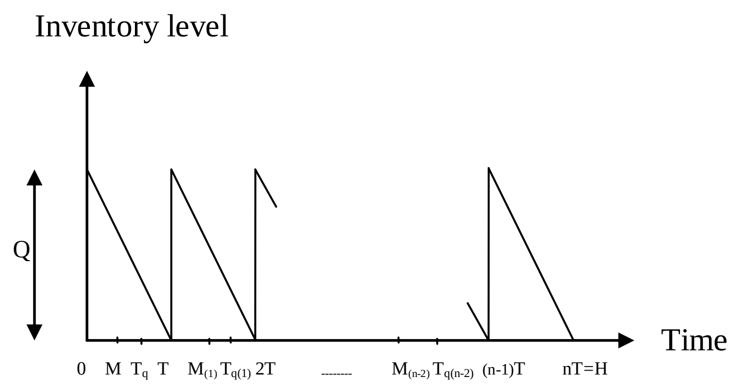
$$= \left[\frac{I_c c_2 D}{\theta^2} \left\{ e^{\theta(T-M)} - 1 \right\} - \frac{I_c c_2 D}{\theta} (T-M) \right] \left(\frac{e^{rH}-1}{e^{rT}-1} \right) \tag{11}$$

The interest earned

$$= I_e \sum_{\alpha=0}^{n-1} p e^{r\alpha T} \int_0^M Dtdt$$

$$= \frac{I_e pD}{2} M^2 \left(\frac{e^{rH}-1}{e^{rT}-1} \right) \tag{12}$$

Case 4: $M \le T_q \le T$



In this case replenishment time is more than or equal to the time where minimum order quantity at which the delay in payments is permitted and trade credit period so case 4 is similar to case 3

The interest charged

$$= I_c \sum_{\alpha=0}^{n-1} c_2 e^{r\alpha T} \int_M^T I(t+\alpha T)dt$$

$$= \left[\frac{I_c c_2 D}{\theta^2} \left\{ e^{\theta(T-M)} - 1 \right\} - \frac{I_c c_2 D}{\theta} (T - M) \right] \left(\frac{e^{rH} - 1}{e^{rT} - 1} \right) \qquad (13)$$

The interest earned

$$= I_e \sum_{\alpha=0}^{n-1} p e^{r\alpha T} \int_0^M D t dt$$

$$= \frac{I_e p D}{2} M^2 \left(\frac{e^{rH} - 1}{e^{rT} - 1} \right) \qquad (14)$$

Now total cost in whole planning horizon H

For Case 1

TC = Ordering Cost + Purchasing cost +Inventory holding cost+ Interest charged-Interest earned
Replace all relevant values

$$TC(0 < T < T_q) = \left[c_3 + c_2 \frac{D}{\theta} \left(e^{\theta T} - 1 \right) + \frac{c_2 D (c_1 + I_c)}{\theta^2} \left(e^{\theta T} - \theta T - 1 \right) \right] \left(\frac{e^{rH} - 1}{e^{rT} - 1} \right)$$

$$TC(0 < T < T_q) = \left[c_3 + c_2 D \left\{ T + 0.5 (c_1 + \theta + I_c) T^2 \right\} \right] \frac{2(e^{rH} - 1)}{r(2T + rT^2)} \quad \text{(nearly)} \qquad (15)$$

$$\left[e^{\theta} = 1 + \theta T + \frac{(\theta T)^2}{2} (nearly) \right]$$

Differentiating (15) w.r.t. T, and equating to zero we get

$$T_1 = \frac{c_3 r + \sqrt{(c_3 r)^2 + 2 c_2 c_3 D \psi_1}}{c_2 D \psi_1} \qquad \text{where } \psi_1 = c_1 + \theta + I_c - r \qquad (16)$$

and also

$$\left. \frac{d^2 (TC)}{dT^2} \right]_{T_1} = \frac{2(e^{rH} - 1)}{r(2T_1 + rT_1^2)^2} \left[-2 c_3 r + 2 c_2 D \psi_1 T_1 \right] > 0 \qquad (17)$$

Therefore T_1 is the optimal value in this case. Put this value in equation (3), we get

$$Q^*_{T_1} = \frac{D}{\theta} \left[e^{\theta T_1} - 1 \right] \qquad (18)$$

For Case 2

TC = Ordering Cost + Purchasing cost +Inventory holding cost+ Interest charged-Interest earned
Replace all relevant values

$$TC\left(T_q \le T < M\right) = \left[c_3 + c_2 \frac{D}{\theta}\left(e^{\theta T} - 1\right) + \frac{c_1 c_2 D}{\theta^2}\left(e^{\theta T} - \theta T - 1\right) - I_e pD\left(TM - 0.5T^2\right)\right]\left(\frac{e^{rH} - 1}{e^{rT} - 1}\right)$$

$$TC\left(T_q \le T < M\right) = \left[c_3 + D(c_2 - I_e pM)T + 0.5D\left(c_2\theta + c_1 c_2 + pI_e\right)T^2\right]\left[\frac{2\left(e^{rH} - 1\right)}{r\left(2T + rT^2\right)}\right] \quad \text{(nearly)}$$

(19)

Differentiating (19) w.r.t. T, and equating to zero we get

$$T_2 = \frac{c_3 r + \sqrt{(c_3 r)^2 + 2c_3 D\psi_2}}{D\psi_2} \text{ where } \psi_2 = c_2\left(c_1 + \theta - r\right) + pI_e\left(1 + Mr\right) \quad (20)$$

and also

$$\left.\frac{d^2(TC)}{dT^2}\right]_{T_2} = \frac{2\left(e^{rH} - 1\right)}{r\left(2T_2 + rT_2^{\,2}\right)^2}\left[-2c_3 r + 2D\psi_2 T_2\right] > 0 \quad (21)$$

Therefore T_2 is the optimal value in this case. Put this value in equation (3), we get

$$Q^*_{T_2} = \frac{D}{\theta}\left(e^{\theta T_2} - 1\right) \quad (22)$$

For Case 3

TC = Ordering Cost + Purchasing cost +Inventory holding cost+ Interest charged-Interest earned
Replace all relevant values

$$TC\left(T_q \le M \le T\right) = \left[\begin{array}{l} c_3 + c_2 \dfrac{D}{\theta}\left(e^{\theta T} - 1\right) + \dfrac{c_1 c_2 D}{\theta^2}\left(e^{\theta T} - \theta T - 1\right) \\ + \dfrac{I_c c_2 D}{\theta^2}\left(e^{\theta(T-M)} - 1\right) - \dfrac{I_c c_2 D}{\theta}\left(T - M\right) - 0.5pI_e DM^2 \end{array}\right]\left(\frac{e^{rH} - 1}{e^{rT} - 1}\right)$$

$$TC\left(T_q \le T \le M\right) = \left[c_3 + c_2 D\left\{T + 0.5\left(c_1 + \theta\right)T^2 + 0.5I_c\left(T - M\right)^2\right\} - 0.5pI_e DM^2\right]\left[\frac{2\left(e^{rH} - 1\right)}{r\left(2T + rT^2\right)}\right] \text{(nearly)}$$

(23)

Differentiating (23) w.r.t. T, and equating to zero we get

$$T_3 = \frac{\left(2c_3 + \psi_3\right)r + \sqrt{\left[\left(2c_3 + \psi_3\right)r\right]^2 + 4c_2 D\psi_4\left(2c_3 + \psi_3\right)}}{2c_2 D\psi_4} \text{ where } \psi_3 = DM^2\left(c_2 I_c - pI_e\right)$$

and $\psi_4 = c_1 + \theta - r + I_c\left(1 + Mr\right)$ (24)

and also

$$\left.\frac{d^2(TC)}{dT^2}\right]_{T_3} = \frac{2\left(e^{rH} - 1\right)}{r\left(2T_3 + rT_3^{\,2}\right)^2}\left[2c_2 D\psi_4 T_3 - \left(2c_3 + \psi_3\right)r\right] > 0 \quad (25)$$

Therefore T_3 is the optimal value in this case. Put this value in equation (3), we get

$$Q^*_{T_3} = \frac{D}{\theta}\left(e^{\theta T_3} - 1\right) \quad (26)$$

For Case 4

TC = Ordering Cost + Purchasing cost +Inventory holding cost+ Interest charged-Interest earned
Replace all relevant values

$$TC\left(T_q \le M \le T\right)=\begin{bmatrix} c_3 + c_2\dfrac{D}{\theta}\left(e^{\theta T}-1\right)+\dfrac{c_1c_2D}{\theta^2}\left(e^{\theta T}-\theta T-1\right) \\ +\dfrac{I_c c_2 D}{\theta^2}\left\{e^{\theta(T-M)}-1\right\}-\dfrac{I_c c_2 D}{\theta}\left(T-M\right)-0.5pI_e DM^2 \end{bmatrix}\left(\frac{e^{rH}-1}{e^{rT}-1}\right)$$

$$TC\left(T_q \le T \le M\right)=\left[c_3 + c_2 D\left\{T+0.5\left(c_1+\theta\right)T^2+0.5I_c\left(T-M\right)^2\right\}-0.5pI_e DM^2\right]\left[\frac{2\left(e^{rH}-1\right)}{r\left(2T+rT^2\right)}\right] \text{ (nearly)} \tag{27}$$

Differentiating (27) w.r.t. T, and equating to zero we get

$$T_4 = \frac{\left(2c_3+\psi_3\right)r+\sqrt{\left[\left(2c_3+\psi_3\right)r\right]^2+4c_2D\psi_4\left(2c_3+\psi_3\right)}}{2c_2D\psi_4} \text{ where } \psi_3 = DM^2\left(c_2I_c - pI_e\right) \text{ and}$$

$$\psi_4 = c_1+\theta-r+I_c\left(1+Mr\right) \tag{28}$$

and also

$$\left.\frac{d^2(TC)}{dT^2}\right]_{T_4} = \frac{2\left(e^{rH}-1\right)}{r\left(2T_4+rT_4^{\,2}\right)^2}\left[2c_2D\psi_4T_4-\left(2c_3+\psi_3\right)r\right]>0 \tag{29}$$

Therefore T_4 is the optimal value in this case. Put this value in equation (3), we get

$$Q^*_{T_4} = \frac{D}{\theta}\left[e^{\theta T_4}-1\right] \tag{30}$$

4. NUMERICAL EXAMPLE

For Case 1

Take H=1Year, D=100units/yr., c_1=Rs.3/unit/yr., c_2=Rs.10/unit, c_3= Rs.50/order, r=0.03/unit, p=Rs.20/unit, θ =0.01, I_c=0.05/ Rs./year, q=80

We get, T_q=0.796817, T_1=0.182164

Clearly $0<T_1<T_q$ and $\left.\frac{d^2(TC)}{dT^2}\right]_{T_1} = 16747.9 > 0$ therefore

$T^* = T_1 = 0.182164, Q^* = 18.233, TC^* = 1572.42$

For Case 2

Take H=1Year, M=90days, D=300units/yr., c_1=Rs.3/unit/yr., c_2=Rs.10/unit, c_3=Rs.250/order, r=0.03/unit, p=Rs.20/unit, θ =0.01, I_e=0.05/Rs./year, q=50

We get, T_q=0.166528, T_2=0.233406

Clearly $T_q<T_2<M$ and $\left.\frac{d^2(TC)}{dT^2}\right]_{T_2} = 39778.3 > 0$ therefore

$T^* = T_2 = 0.233406$, $Q^* = 70.1036$, $TC^* = 5145.01$

For Case 3

Take H=1Year, M=60 days, D=300units/yr., c_1=Rs.3/unit/yr., c_2=Rs.10/unit, c_3=Rs.250/order, r=0.03/unit, p=Rs.20/unit, θ =0.01, I_c=0.05/Rs./year, I_e=0.06/Rs./year, q=40

We get, T_q=0.133245, T_3=0.234005

Clearly $T_q<M<T_3$ and $\left.\frac{d^2(TC)}{dT^2}\right]_{T_3} = 39025.1 > 0$ therefore

$T^* = T_3 = 0.234005$, $Q^* = 70.2838$, $TC^* = 5164.82$

For Case 4

Take H=1Year, M=30 days, D=300units/yr.,c_1=Rs.3/unit/yr.,c_2=Rs.10/unit, c_3=Rs.250/order, r=0.03/unit, p=Rs.20/unit, θ =0.01, I_c=0.05/Rs./year, I_e=0.06/Rs./year, q=40

We get, T_q=0.133245, T_4=0.235019

Clearly $M<T_q<T_4$ and $\left.\frac{d^2(TC)}{dT^2}\right]_{T_4} = 38853.5 > 0$ therefore

$T^* = T_4 = 0.235019$, $Q^* = 70.5886$, $TC^* = 5186.53$

5. SENSITIVITY ANALYSIS

In this section, we study that if there is change in one parameter at a time while keeping remaining unchanged, how it affects the optimal values of replenishment cycle, Order quantity and total cost. The sensitivity analysis has been performed by increasing the parameters then analyze the effect on optimal values of replenishment cycle, Order quantity and total cost.

5.1 Sensitivity analysis on deterioration rate

Deterioration rate (θ)	Replenishment time interval (T^*)	EOQ (Q^*)	Total Cost (TC^*)
0.01	0.182164	18.233	1572.42
0.02	0.181863	18.2194	1573.35
0.03	0.181564	18.2059	1574.27

On the basis of the results shown in above table, the following observations can be made.

Higher the value of deterioration rate results lower value of order quantity, decrease of replenishment time interval but increase in total cost.

5.2 Sensitivity analysis on inventory holding cost

Inventory holding cost (c_1)	Replenishment time interval (T^*)	EOQ (Q^*)	Total Cost (TC^*)
3	0.182164	18.233	1572.42
4	0.157897	15.8022	1658.07
5	0.141298	14.1397	1733.6

On the basis of the results shown in above table, the following observations can be made.

Higher the value of holding cost results lower value of order quantity, decrease of replenishment time interval but increase in total cost.

5.3 Sensitivity analysis on ordering cost

Ordering cost (c_3)	Replenishment time interval (T^*)	EOQ (Q^*)	Total Cost (TC^*)
250	0.233406	70.1036	5145.01
300	0.255769	76.8288	5351.77
350	0.276346	83.0186	5541.79

On the basis of the results shown in above table, the following observations can be made.

Higher the value of ordering cost results larger value of order quantity, increase of replenishment time interval and increase in total cost.

5.4 Sensitivity analysis on credit period

credit period (M)	Replenishment time interval (T^*)	EOQ (Q^*)	Total Cost (TC^*)
60	0.234005	70.2838	5764.82
75	0.233244	70.0548	5151.72
90	0.23231	69.774	5137.02

On the basis of the results shown in above table, the following observations can be made:

Higher the credit period M, results lower value of order quantity, decrease of replenishment time interval and decrease in total cost.

5.5 Sensitivity analysis on inflation rate

inflation rate (r)	Replenishment time interval (T^*)	EOQ (Q^*)	Total Cost (TC^*)
0.03	0.235019	70.5886	5186.53
0.06	0.237026	71.192	5247.00
0.09	0.23907	71.8067	5308.47

On the basis of the results shown in above table, the following observations can be made:

Higher the value of inflation rate (r) results larger value of order quantity, increase of replenishment time interval and increase in total cost.

6. CONCLUSION AND FUTURE RESEARCH

In this proposed model, we present a deterministic inventory model with constant demand. Model is considered for finite planning horizon under inflationary conditions. An EOQ model for perishable items has been established in which supplier credits are linked to order quantity Different results of calculus have been used to establish the model.The present model may be extended in several ways. For instance, we may extend the model to allow for a varying rate of deterioration. Additionally, we could consider time dependent demand, Price dependent demand, stock dependent holding cost. We could extend this model for infinite planning horizon and allowed for shortages.

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7. REFERENCES

[1] S.K. Goyal, Economic order quantity under conditions of permissible delay in payments, J. Oper. Res. Soc. 46 (1985) 335–338.
[2] P. Chu, K.J. Chung, S.P. Lan, Economic order quantity of deteriorating items under permissible delay in payments, Comput. Oper. Res. 25 (1998) 817–824.
[3] K.J. Chung, The inventory replacement policy for deteriorating items under permissible delay in payments, Oper. Res. 37 (2000) 267–281.
[4] A.M.M. Jamal, B.R. Sarker, S. Wang, Optimal payment time for a retailer under permitted delay in payment by a wholesaler, Int. J. Prod. Econ. 66 (2000)59–66.
[5] B.R. Sarker, A.M.M. Jamal, S. Wang, Optimal payment time under permissible delay in payment for products with deterioration, Prod. Plan. Control 11(2000) 380–390.
[6] N.H. Shah, Inventory model for deteriorating items and time value of money for a finite time horizon under the permissible delay in payments, Int. J.Syst. Sci. Sci. 37 (2006) 9–15.
[7] J.A. Buzacott, Economic order quantities with inflation, Oper. Res. 26 (1975) 553–558.
[8] J. Moon, S. Lee, The effects of inflation and time value of money on an economic order quantity model with a random production life cycle, Eur. J. Oper.Res. 125 (2000) 588–601.
[9] J.M. Chen, An Inventory model for deteriorating items with time-proportional demand and shortages under inflation and time discounting, Int. J. Prod.Econ. 55 (1998) 21–30.
[10] J.K. Dey, S. Kar, M. Maiti, An EOQ model with fuzzy lead time over a finite time horizon under inflation and time value of money, Tamsui Oxford J.Manag. Sci. 20 (2004) 57–77.
[11] G. Padmanavan, P. Vrat, A analysis of multi-item inventory systems under resource constraints; a non-linear goal programming approach, Eng. Costsand Prod. Econ. 20 (1990) 121–127.
[12] M. Hariga, M. Ben-daya, Optimal time-varying lot sizing models under inflationary conditions, Eur. J. Oper. Res. 89 (1996) 313–325.
[13] C.K. Jaggi, K.K. Aggarwal, S.K. Goyal, Optimal Order Policy for Deteriorating Items with Inflation Induced Demand, Int. J. Prod. Econ. 103 (2006) 707–714.
[14] L.H. Chen, F.S. Kang, Integrated Inventory models considering permissible delay in payment and variant pricing strategy, Appl. Math. Model 34 (2010)36–46.
[15] C. Huang, An integrated inventory model under conditions of order processing cost reduction and permissible delay in payments, Appl. Math. Model.34 (2010) 1352–1359.
[16] R.P. Tripathi, S.S. Mishra, H.S. Shukla, A cash flow oriented EOQ model under permissible delay in payments, Int. J. Eng. Sci. Tech. 2 (2010) 123–131.
[17] H.C. Liao, C.H. Tsai, C.T. Su, An inventory model with deteriorating items under inflation when a delay in payment is permissible, Int. J. Prod. Econ. 63(2000) 207–214.
[18] K.J. Chung, J.J. Liao, Lot-sizing decisions under trade credit depending on the ordering quantity, Comput. Oper. Res. 31 (2004) 909–928.
[19] C.T. Chang, An EOQ model with deteriorating items under inflation when supplier credits linked to ordering quantity, Int. J. Prod. Econ. 88 (2004) 307–316.

[20] P.C. Yang, Pricing strategy for deteriorating items using quantity discount when demand is price sensitive, Eur. J. Oper. Res. 157 (2004) 389–397.
[21] S.R. Singh, N. Kumar, R. Kumari, Two-warehouse Inventory Model for Deteriorating Items with Shortages under Inflation and Time-value of Money, Int.J. Comput. Appl. Math. 41 (2009) 83–94.
[22] K.J. Chung, C. Huang, An ordering policy with allowable shortage and permissible delay in payments, Appl. Math. Model. 33 (2009) 2518–2525.
[23] L.E.C. Barron, N.R. Smith, S.K. Goyal, Optimal order size to take advantage of a one-time discount offer with allowed backorders, Appl. Math. Model. 34(2010) 1642–1652.
[24] A. Guria, S.K. Mondal, C. Guria, M. Maiti, Pricing model for petrol/diesel and inventory control under permissible delay in payment for petrol/diesel retailing station, Int. J. Oper. Res., In press.
[25] D. Panda, M. Maiti, Multi-item inventory models with price dependent demand under flexibility and reliability consideration and imprecise space constraint: A geometric programming approach, Math. Comput. Model. 49 (2009) 1733–1749.
[26] J.S. Kim, H. Hwang, S.W. Shinn, An optimal credit policy to increase supplier's profit with price-dependent demand functions, Prod. Plan. Control 6(1995) 45–50.
[27] P.L. Abad, Optimal Pricing and Lot-Sizing Under Conditions of Perish ability, Finite Production and Partial Backordering and Lost Sale, Eur. J. Oper. Res.144 (2003) 677–685.
[28] C.K. Jaggi, K.K. Aggarwal, P. Verma, Two warehouse inventory model for deteriorating items demand is price sensitive, Int. J. Oper. Res. 7 (2010) 530–551.
[29] C.K. Jaggi, A.K. Aggarwal, P. Verma, Inventory and pricing strategies for deteriorating items with limited capacity and time-proportional backloggingrate, Int. J. Oper. Res. 8 (2010) 331–354.
[30] Y. Liang, F. Zhou, A two-warehouse inventory model for deteriorating items under conditionally permissible delay in payment, Appl. Math. Model. 35(2011) 2221–2231.
[31] J.K. Dey, S.K. Mondal, M. Maiti, Two storage inventory problem with dynamic demand and interval valued lead-time over finite time horizon under inflation and time-value of money, Eur. J. Oper. Res. 185 (2008) 170–194.
[32] A.K. Maiti, M.K. Maiti, M. Maiti, Inventory model with stochastic lead-time and price dependent demand incorporating advance payment, Appl. Math. Model. 33 (2009) 2433–2443.
[33] C. Gurnani, Economic Analysis of Inventory systems, Int. J. Prod. Res. 21 (1983) 261–277.
[34] A.K. Maiti, M.K. Maiti, M. Maiti, Two storage inventory model with fuzzy deterioration over a random planning horizon, Appl. Math. Comput. 183 (2006) 1084–1097.
[35] I. Moon, W. Yun, An economic order quantity model with random planning horizon, The Engineering Economist 39 (1993) 77–86.
[36] S. Pal, M.K. Maiti, M. Maiti, An EPQ model with price discounted promotional demand in an imprecise planning horizon via Genetic Algorithm, Comput.Ind. Eng. 57 (2009) 181–187.