

**AN INVENTORY REPLENISHMENT POLICY FOR
DETERIORATING ITEMS UNDER INFLATION IN A STOCK
DEPENDENT CONSUMPTION MARKET WITH SHORTAGE**

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Abstract

An economic order quantity (EOQ) inventory model for deteriorating goods is developed under inflation in a stock dependent consumption market with finite replenishment rate and with permitting shortages. The effects of inflation and time value of money are incorporated into the model. It is assumed that the goods in the inventory are deteriorating over time at a constant rate. The inventory policy is discussed over a finite time-horizon with several reorder points. The results are discussed with a numerical example and a sensitivity analysis of the optimal solution with respect to the parameters of the system is carried out.

Key words: Inventory, replenishment, deterioration, stock-dependent consumption, inflation, backordering, time-value of money.

1. INTRODUCTION

One of the most developed fields of Operations Research is inventory modeling. Inventory has been defined by Monks, as idle resources that have certain economic value. Usually, it is an important component of the investment portfolio of any production system. Keeping an inventory for future sales or use is very common in business. Retail firms, wholesalers, manufacturing companies and even blood banks generally have a stock of goods on hand. Quite often the demand rate is decided by the amount of the stock level. The motivational effect on the people may be caused by the presence of stock at times. Large quantities of goods displayed in markets according to seasons motivate the customers to buy more. If the stock is insufficient the customers may prefer some other brands. Thus, shortages may fetch loss to the producers. The shortage or stock out cost is the penalty incurred for being unable to meet the demand when it occurs.

Most of the classical inventory models did not take into account the effects of inflation and time value of money. Perhaps, it was believed that inflation would not influence the cost and price components to any significant degree. However, in the last several years most of the countries have suffered from large-scale inflation and sharp decline in the purchasing power of money. As a result, while determining the optimal inventory policy, the effects of inflation and time value of money cannot be ignored.

It has been observed in supermarkets that the demand rate is usually influenced by the amount of stock level, that is, the demand rate may go up or down with the on-hand stock level. As pointed out by Levin *et al.* (1972) at times, the presence of inventory has a motivational effect on the people around it. It is common belief that large piles of goods displayed in a supermarket will lead the customers to buy more. In the last several years, many researchers have given considerable attention to the situation where the demand rate is dependent on the level of the on-hand inventory. Gupta and Vrat (1986) were the first to develop models for stock-dependent consumption rate. Mandal and Phaujdar (1989) then developed an economic production quantity model for deteriorating items with stock dependent consumption rate.

Deterioration is defined as decay, spoilage, loss of utility of the product as defined by Shah and Shukla (2009). Product such as vegetables, fish, medicine, blood, radio-active chemicals have finite self life and start to deteriorate once they are produced. A decaying item such as photographic film, fruit and some electronic goods like capacitor gradually loses its potential. When a price increase of components is anticipated, companies may purchase large amounts of items without considering related costs. However ordering large quantities would not be economical if the items in the inventory system deteriorate and demand depends on the stock level. Therefore, developing an inventory model under inflation for stock dependent consumption market and deteriorating items is highly desirable.

Several researchers have examined the inflationary effect on an inventory policy. Buzacott (1975) developed the first EOQ model taking inflation into account by assuming a constant inflation rate. In the same year Mishra (1975) also developed an economic order quantity (EOQ) model incorporating inflationary effects. Both the model of Buzacott and Mishra

(1975) assume a uniform inflation rate for all the associated costs and minimize the average annual cost to derive an expression for the EOQ. Brahmabhatt (1982) developed an EOQ model under a variable inflation rate and marked – up prices. Later Hwang and Sohn (1983) developed a deterministic inventory model for items that deteriorate continuously and follow an exponential distribution. Moreover, Gupta and Vrat (1986) developed a multi-item inventory model with a resource constraint system under a variable inflation rate.

Other researchers also extended their approach to various interesting situations by considering the internal cost at finite replenishment rate, shortage, etc. The models of Vanttes and Mohnemius (1972), Jeyachandra and Bahner (1985), Aggarwal (1981), Mishra (1975, 1979), Bierman and Thomas (1977), Sarkar and Pan (1994), etc. are worth mentioning in this direction. In all these studies, the market demand rate was assumed to be a constant. Dutta and Pal (1991) investigate a finite time-horizon inventory model following the approach of Mishra (1979) with a linearly time dependent demand rate, allowing shortages and considering the effects of inflation and time value of money. Bose (1995) have also developed an EOQ model for deteriorating items incorporating the effects of inflation, time value of money, a linearly time-dependent demand and shortages.

Other investigators have described inventory policies for decaying items. Ghare and Schrader (1963) first analyzed the decaying inventory problem and also developed a relatively simple EOQ model with a constant decay rate. Covert and Philip (1973) derived a revised form of the EOQ model under the assumption of Weibull distribution deterioration. Also Cohen (1977) formulated and solved an inventory model by simultaneously considering pricing and

ordering policies for exponentially decaying inventory. Moreover Dave (1979) proposed a deterministic inventory model in continuous units and discrete time for deteriorating items.

Many studies have modified inventory policies by considering the ‘stock dependent consumption rate’ Gupta and Vikash (1986) considered this phenomenon by using the following relation: $\lambda = \alpha \pm \beta Q^T$, $\lambda = \alpha + \beta e^Q$, $\lambda = \alpha - \beta e^{-Q}$, where α , β , T are positive constants and λ is stock dependent consumption rate and Q is ordering quantity. Mandal and Phaujdar (1989) suggested that the demand rate depends on the current stock level. Also in the same year Mandal and Phaujdar (1989) developed a model for deteriorating items with a stock dependent consumption rate.

Baker and Urban (1988) developed Inventory models with inventory-level-dependent demand rate and relaxed terminal conditions. Patra, Lenka and Ratha (2010) developed an inventory model for deteriorating items in a single warehouse system with price dependent demand in non-linear (quadratic) form. In addition, Vrat and Padmanavan (1990) developed an inventory model under a constant inflation rate items. Dutta and Pal (1990) studies the inventory problems for deteriorating items with inventory level-dependent rate and shortages. Pal, Goswami and Chaudhuri (1993) developed a deterministic inventory model for deteriorating items with stock dependent demand rate. Again, Patra and Ratha (2010) developed an economic order quantity model for deteriorating items with increasing time varying demand and cost. Liao, Tong and Su (1996) developed an inventory model under inflation for stock dependent consumption rate and exponential decay. Ray and Chaudhuri (1997) developed an EOQ model with stock-dependent demand, shortages, inflation and time discounting.

To fit into realistic circumstances we have developed a finite planning horizon inventory model for deteriorating items with stock-dependent consumption rate. Here, shortages and backlog are allowed. In addition, the effects of inflation and time value of money on replenishment policy under instantaneous replenishment with zero lead-time are also considered. A numerical example is presented to examine the effects of inflation, deterioration and stock dependent consumption. In addition, the sensitivity analysis of the optimal solution with respect to parameters of the system is carried out.

2. DEVELOPMENT OF THE MODEL

The model is developed with the following notations and assumptions:

Assumptions:

- (i) The unit price is subject to the same inflation rate as other inventory related costs, there by implying that the ordering quantity can be determined by minimizing the total cost over a planning period.
- (ii) The replenishment rate is infinite, i.e. the replenishment is instantaneous.
- (iii) Backlogging is allowed.
- (iv) Lead time is zero.
- (v) The inflation rate is constant.
- (vi) The inventory holding cost is constant.

(vii) The inventory deterioration rate is in exponential form.

(viii) Stock dependent consumption rate λ is assumed, in which the demand rate depends on the ordering size and follows the function.

$\lambda = \alpha \pm \beta Q^r, \alpha \pm \beta Q^T, \lambda = \alpha + \beta e^Q, \lambda = \alpha - \beta e^{-Q}$ Where α, β, T positive constant, r is the discount rate and Q is the ordering quantity ($Q \neq 0$).

Notations:

The notation adopted in this paper is as follows:

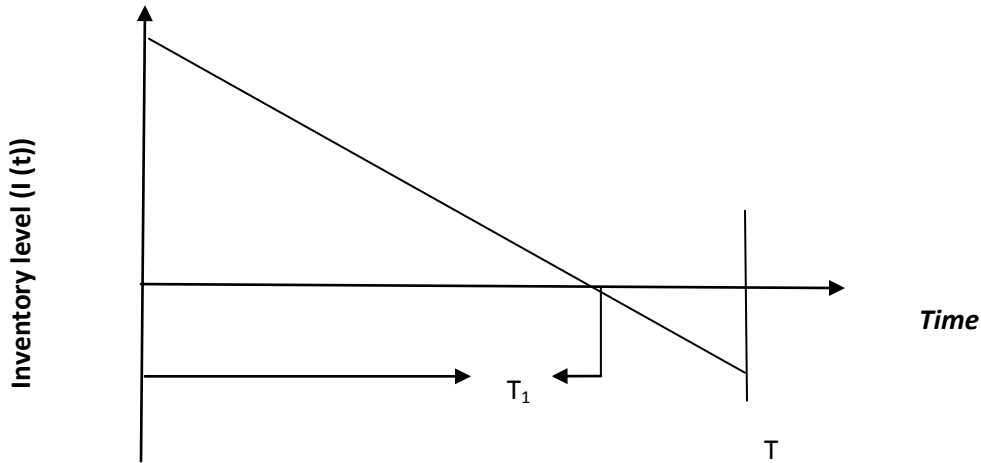
- 1) H : Length of planning horizon.
- 2) T : Length of the inventory cycle.
- 3) T_1 : Length of the period with positive stock of the item.
- 4) K : constant rate of inflation.
- 5) C_1 : is the cost price per unit.
- 6) C_2 : is the ordering cost per order.
- 7) C_3 : is the carrying cost per unit per year.
- 8) C_4 : is the deterioration cost per unit.
- 9) C_5 : is the shortage cost per unit per year.
- 10) $I(t)$: Inventory level at time t .
- 11) Q : Ordering quantity.

- 12) λ : Stock dependent consumption rate.
- 13) r : is the discount rate representing the time-value of money.
- 14) $C(t)$: Unit purchase cost denotes an item bought at time t , i.e. $C(t)=C_1 \cdot e^{rT}$, where C_1 is unit price at time zero and $R= r -K$.
- 15) $O(t)$: Ordering cost, denotes an order placed at time t , i.e. $O(t)=C_2 \cdot e^{rT}$, Where C_2 is the ordering cost per order at time zero.
- 16) $B(t)$: Backorder cost denotes a shortage at time t , i.e. $B(t)=C_5 \cdot e^{KT}$, where C_5 is backordering cost per unit per back order.
- 17) θ : is the deterioration rate of the on-hand inventory.
- 18) C_P : Total Purchase cost.
- 19) C_R : Total Replenishment cost.
- 20) C_C : Total Carrying cost.
- 21) C_D : Total Deterioration cost.
- 22) C_B : Total Backorder cost.
- 23) TC : Total System cost

3. MATHEMATICAL MODELING

Total cost during the planning period H is the sum of purchasing cost, replenishment cost, carrying cost, deterioration cost and backorder cost. The time horizon H is divided into m equal

parts, each of length T . so that $T = H/m$, where m is an integer for the number of replenishments to be made during period H and T is a constant interval of time between replenishments.



For a deterioration rate θ , the inventory level at time t , $I(t)$ during time period $(0 \leq t \leq T_1)$ is given by

$$\frac{dI(t)}{dt} + \theta I(t) = -\lambda, 0 \leq t \leq T_1 \tag{1}$$

The solution to this differential equation is obtained as

$$I(t) = I_0 \cdot e^{-\theta t} + \frac{\lambda}{\theta} (e^{-\theta t} - 1), 0 \leq t \leq T_1 \tag{2}$$

Where at time $t=0$, $I(t)=I_0$. It is obvious that at $t=T_1$, $I(T_1)=0$, so equation (2) becomes

$$I_0 = \frac{\lambda}{\theta} (e^{\theta T_1} - 1) = Q \tag{3}$$

Substituting this value I_0 , in equation (2), we get

$$I(t) = \frac{\lambda}{\theta} [e^{\theta(T_1-t)} - 1], 0 \leq t \leq T_1 \tag{4}$$

And $I(t) = 0$, when $T_1 \leq t \leq T$

The Total purchasing cost in $(0, H)$ is

$$C_p = Q [C_1(0) + C_1(T) + C_1(2T) + \dots + C_1(m-1)T]$$

$$C_p = Q.C_1 \left(\frac{e^{RH} - 1}{e^{RT} - 1} \right) \tag{5}$$

Then the Total replenishment cost in $(0, H)$ is

$$C_R = C_2(0) + C_2(T) + C_2(2T) + \dots + C_2(m-1)T$$

$$C_R = C_2 \left(\frac{e^{RH} - 1}{e^{RT} - 1} \right), \text{ where } R = r - K \tag{6}$$

For inventory carrying cost, let $I(t)$ be the inventory level at time t , since $Q = \frac{\lambda}{\theta} [e^{\theta T_1} - 1]$, from equation (3)

We have

$$Q = \frac{\lambda}{\theta} [e^{\theta(T_1-t)} - 1], 0 \leq t \leq T_1 \tag{7}$$

And, the Total carrying cost in $(0, H)$ is given by

$$C_C = \int_0^{T_1} \frac{\lambda}{\theta} [e^{\theta(T_1-t)} - 1] \cdot C_3 \cdot e^{-Rt} \cdot dt \tag{8}$$

The Total deterioration cost in (0, H) is

$$C_D = C_4(T_1) + C_4(2T_1) + \dots + C_4 m T_1$$

$$C_D = C_4 \left(\frac{e^{RH} - 1}{e^{RT_1} - 1} \right) \tag{9}$$

The Total back ordering cost in (0, H) is

$$C_B = C_5(T - T_1) + C_5 \cdot 2(T - T_1) + \dots + C_5 m(T - T_1)$$

$$C_B = C_5 \cdot \left(\frac{e^{RH} - 1}{e^{R(T-T_1)} - 1} \right) \tag{10}$$

Now the Total cost of the system in (0, H) is

$$\text{Total Cost (TC)} = C_P + C_R + C_C + C_D + C_B$$

$$TC = Q \cdot C_1 \left(\frac{e^{RH} - 1}{e^{RT} - 1} \right) + C_2 \left(\frac{e^{RH} - 1}{e^{RT} - 1} \right) + \int_0^{T_1} \frac{\lambda}{\theta} [e^{\theta(T_1-t)} - 1] \cdot C_3 \cdot e^{-Rt} \cdot dt + C_4 \left(\frac{e^{RH} - 1}{e^{RT_1} - 1} \right) + C_5 \cdot \left(\frac{e^{RH} - 1}{e^{R(T-T_1)} - 1} \right) \tag{11}$$

$$e^{\theta T_1} = 1 + \theta T_1 + \frac{\theta^2 T_1^2}{2}, \text{ by taking up to second order}$$

$$Q = \frac{\lambda}{\theta} (e^{\theta T_1} - 1)$$

$$Q = \frac{\lambda T_1 (2 + \theta T_1)}{2}, \text{ hence } \lambda = \frac{2Q}{2T_1 + \theta T_1^2}$$

As, $\lambda = \alpha + \beta Q^r$

$$\Rightarrow \frac{\theta}{2} T_1^2 + T_1 - \frac{Q}{\alpha + \beta Q^r} = 0$$

$$\Rightarrow N(Q) = T_1 = \frac{-1 + \sqrt{1 + \frac{2\theta Q}{\alpha + \beta Q^r}}}{\theta}$$

Let, $M(Q) = R.N(Q) [1 + R.N(Q)]$

$W(Q) = 2 + \theta.N(Q)$

$Z(Q) = R.(T - N(Q)) [2 + R.(T - N(Q))]$

$$TC = \frac{2R.H + R^2 H^2}{M(Q)} \left[C_1 + \frac{Q.C_1 N(Q)}{W(Q)} + C_3 \right] + C_2 \cdot \frac{2.R.H + R^2 H^2}{Z(Q)} + \sum_{m=1}^{n-1} e^{-R(m-1)T} \cdot C_2 \left[\frac{\alpha}{\theta} (e^{\theta H} - e^{(m-1)\theta T}) + \frac{\beta}{\theta^2} \{ (H\theta - 1)e^{\theta H} - e^{(m-1)\theta T} \cdot (m-1)\theta T - 1 \} \right] + \sum_{m=1}^{n-1} C_3 \cdot e^{-R(m-1)T} \cdot \frac{e^{\theta(m-1)T}}{\theta^2} \left[\alpha\theta (e^{R\theta T} - 1) + \beta e^{R\theta T} \{ \theta(R + m - 1)T - 1 \} + \beta - \beta\theta(m-1)T \right] + \sum_{m=1}^{n-1} C_4 \cdot e^{-R(R-1)T} \left[\frac{1}{R} \{ -\beta(1-R)^2 T^2 + \alpha(1-R)T_1 + \beta m(1-R)T^2 \} - \frac{1}{R^2} \{ \alpha + 2\beta(1-R)T_1 - \beta.m.T_1 \} - \frac{2\beta}{R^3} \right] + \sum_{m=1}^{n-1} C_5 e^{-R.m.T_1} \left[\frac{\alpha}{R^2} + \frac{\beta.m.T}{R^2} + \frac{2\beta}{R^3} \right]$$

(12)

Total cost in equation (12) is convex. Hence, to determine optimal ordering quantity, the equation (12) is to be differentiated with respect to, T, Q and K and equated to zero.

$$\begin{aligned} \frac{dTC}{dT} &= 0 \\ \Rightarrow \sum_{m=1}^{n-1} -C_1.R.(n-1).e^{-R.(m-1)T} &\left[\frac{\alpha}{\theta} (e^{\theta H} - e^{(m-1)\theta T}) + \frac{\beta}{\theta^2} \{ (H\theta - 1)e^{\theta H} - e^{(m-1)\theta T} .(n-1)\theta T - 1 \} \right] \\ - \sum_{m=1}^{n-1} C_2.R.(n-1).e^{-R.(m-1)T} &\cdot \frac{e^{\theta(m-1)T}}{\theta^2} \left[\alpha\theta (e^{R\theta T} - 1) + \beta e^{R\theta T} \{ \theta(R+m-1)T - 1 \} + \beta - \beta\theta(m-1)T \right] \\ + \sum_{m=1}^{n-1} C_2.e^{-R.(m-1)T} &\cdot \frac{e^{\theta(m-1)T}}{\theta^2} \left[\alpha\theta^2 R.e^{R\theta T} + \beta R\theta e^{R\theta T} \{ \theta(R+m-1)T - 1 \} + \beta\theta e^{R\theta T} (R+m-1) - \beta\theta(m-1) \right] \\ + \sum_{m=1}^{n-1} C_3.e^{-R.(R+m-1)T} &\cdot -R(R+m-1) \left[\frac{1}{R} \{ -\beta(1-R)^2 T^2 + \alpha(1-R)T + \beta m(1-R)T^2 \} - \frac{1}{R^2} \{ \alpha + 2\beta(1-R)T - \beta mT \} - \frac{2\beta}{R^3} \right] \\ + \sum_{m=1}^{n-1} C_4.e^{-R.(R+m-1)T_1} &\left[\frac{1}{R} \{ -2\beta(1-R)^2 T_1 + \alpha(1-R) + 2\beta m(1-R)T + 2\beta(1-R)T_1 - \beta m \} \right] + \sum_{m=1}^{n-1} C_5 \cdot -R.m.e^{-R.T_1} \left[\frac{\alpha}{R^2} + \frac{\beta m T_1}{R^2} + \frac{2\beta}{R^3} \right] \\ + \sum_{m=1}^{n-1} C_5.e^{-R.mT_1} &\frac{\beta m}{R^2} = 0 \end{aligned}$$

Taking derivative of TC with respect to Q, we get

$$\begin{aligned} \Rightarrow \frac{-2R.H(1+R.H).M'(Q)}{\{M(Q)\}^2} &\left[\frac{Q.C_1 N(Q)}{W(Q)} \right] + \frac{2R.H + R^2 H^2}{M(Q)} \left[\frac{C_1 \{ N(Q) + Q.N(Q) \} W(Q) - Q.N(Q).W'(Q)}{W^2(Q)} \right] \\ - \frac{R.H(2+R.H)}{\{Z(Q)\}^2} &= 0 \end{aligned}$$

$$\text{Here, } N'(Q) = \frac{\alpha + \beta Q^r - r\beta Q^r}{(\alpha + \beta Q^r)^{\frac{3}{2}} \cdot (\alpha + \beta Q^r + 2Q\theta)^{\frac{1}{2}}}$$

$$M'(Q) = R.N'(Q)[1 + 2R.N(Q)]$$

$$\text{And, } Z(Q) = R.(T - N(Q))[2 + R.(T - N(Q))]$$

$$Z'(Q) = -2R.N'(Q) - R^2.N'(Q)(T - N(Q)) - R^2N'(Q).(T - N(Q))$$

Now, finding derivative of TC with respect to R, we get

$$\frac{dTC}{dR} = 0$$

$$\begin{aligned} \Rightarrow & C_1 e^{-R(n-1)T} \left[e^{\theta H} \left\{ \frac{-\alpha R(n-1) - \beta(H\theta - 1)R(n-1)}{\theta} \right\} + e^{(n-1)\theta T} \left\{ 2R(n-1) - R(n-1)^2\theta T - \alpha(n-1) - \beta(n-1)^2T - \frac{\beta(n-1)}{\theta} \right\} \right] \\ & + \sum_{m=1}^{n-1} C_2 e^{T(m-1)(\theta-R)} \left[e^{R\theta T} \left\{ -\alpha R\theta(m-1) - \beta R\theta(R+m-1)T + \beta R(m-1) + \alpha\theta^2(m-1)T + \beta\theta^2(m-1)T^2(R+m-1) - \beta\theta(m-1)T \right\} \right. \\ & \left. + \alpha\theta^2 R + \beta R\theta^2(R+m-1)T - \beta R\theta + \beta\theta(R+m-1) \right. \\ & \left. + (m-1) \{ R\alpha\theta - R\beta + \beta R(m-1) - \alpha\theta^2 T + \beta\theta T - \beta\theta^2(m-1)T^2 - \beta\theta \} \right] \\ & + C_3 e^{-RmT} \left[\alpha(1-R) + \beta T(2m+2R-1-2mR-R^2) - Rm\alpha(1-R) - Rm\frac{\beta}{2}(2m+2R-1-2mR-R^2)T^2 \right] \\ & + \sum_{m=1}^{n-1} C_4 e^{-R(R+m-1)T} \left[\frac{(1-R)(-2\beta T_1 + 2\beta R T_1 + \alpha + 2\beta m T) + (R+m-1)(\alpha - 2\beta T + 2\beta R T + \beta m T_1)}{R} \right. \\ & \left. + \frac{2\beta T(1-R) - \beta m + 2\beta(R+m-1) + (1-R)(R+m-1)(\beta T_1^2 - \beta T R - \alpha T_1 - \beta m T_1^2)}{R^2} \right] \\ & + \sum_{m=1}^{n-1} -C_5 m T_1 e^{-RmT} \left[\frac{\alpha}{R^2} + \frac{\beta m T_1}{R^2} + \frac{2\beta}{R^3} \right] + \sum_{m=1}^{n-1} C_5 e^{-RmT} \left[-\frac{2\alpha}{R^3} - \frac{2\beta m T_1}{R^3} - \frac{3\beta}{R^4} \right] = 0 \end{aligned}$$

4. NUMERICAL EXAMPLE

A Numerical example is presented in the following to illustrate the effectiveness of the proposed model. A hypothetical system has the following parameters values:

$$\alpha = 200 \text{ units} \quad \beta = 1 \quad C_1 = \text{Rs } 5.00 \text{ cost per unit}$$

$$C_2 = \text{Rs } 3.00 \text{ per replenishment} \quad C_3 = \text{Rs. } 1.50 / \text{ unit/yr}$$

$$C_4 = \text{Rs } 0.2 / \text{ unit/yr} \quad C_5 = \text{Rs } 1.00 / \text{ unit/yr} \quad H = 1 \text{ year}$$

$$r = 0.08 \quad K = 0.1 \quad \theta = 0.1$$

The optimal ordering quantity is determined by the Newton-Raphson method using the equation (12) as: $Q = 33.16$ units

The optimal total system cost is determined using the equation (12) is $TC = \text{Rs } 689.15$

Also, the effect of K and θ on Q and TC are studied for various values of r by assuming that values for inflation rate K are 0.05, 0.1, 0.15, 0.2 and deterioration rate θ are 0.05, 0.1, 0.15, and 0.2. By using Newton-Raphson method. **Table 1** tabulates the optimal values of ordering quantity Q and the corresponding total system cost TC per unit time. These results provided further insight into the nature of problem studies.

Table 1: Effects of r , θ and K on the Optimal Ordering Quantity and the Optimal Total System Cost

θ	K	0.05				0.10				0.15				0.20			
	r	0.05	0.10	0.15	0.20	0.05	0.10	0.15	0.20	0.05	0.10	0.15	0.20	0.05	0.10	0.15	0.20
0.05	Q	31.97	31.89	31.591	31.41	32.75	32.68	32.58	32.34	32.29	32.09	31.98	31.60	31.57	31.45	31.25	31.11
	TC	680.62	681.05	683.945	688.05	676.35	677.91	678.01	679.499	567.24	568.42	574.19	577.39	503.69	5565.67	579.5	598.25
0.10	Q	31.96	31.88	31.50	31.38	33.24	33.06	32.94	31.56	35.68	39.18	39.956	40.70	41.10	43.79	46.73	49.99
	TC	693.8	695.39	697.61	699.89	687.96	690.56	691.16	692.23	659.79	651.89	650.35	549.42	640.54	631.54	629.59	616.62
0.15	Q	29.99	29.62	29.39	29.158	30.89	30.58	30.389	30.15	33.63	32.89	32.17	31.775	37.53	37.07	35.39	34.55
	TC	695.39	696.51	697.61	698.79	591.53	596.84	598.19	601.66	622.75	627.64	629.85	631.08	611.88	615.30	615.78	619.12
0.20	Q	23.99	23.61	63.29	62.07	28.88	28.47	27.99	27.21	29.47	29.193	29.17	29.13	31.19	31.08	31.00	30.937
	TC	694.39	695.52	696.48	698.49	599.45	601.31	603.24	604.89	624.39	625.39	626.69	627.97	619.11	620.61	621.18	623.10

The above table shows, if we randomly changes deterioration rate ‘ θ ’ by 5 per cent and inflation rate ‘ K ’ by, 5, 10, 15 and 20 per cent and discount rate ‘ r ’ by 5, 10, 15 and 20 per cent.

In the first case, the ordering quantity ‘ Q ’ value decreases and ‘ TC ’ value increases significantly.

In the second case, if ‘ θ ’ changes by 10 percent and K and r changes by 5, 10, 15 and 20 per cent, the ordering quantity ‘ Q ’ value decreases nominal but ‘ TC ’ increases significantly.

In the third case, if ‘ θ ’ changes by 15 percent and K and r changes by 5, 10, 15 and 20 per cent, the ordering quantity ‘ Q ’ value decreases nominal but ‘ TC ’ increases significantly.

In the fourth case, if ' θ ' changes by 20 percent and K and r changes by 5, 10, 15 and 20 per cent, the ordering quantity ' Q ' value decreases by very small amount but ' TC ' increases significantly.

If we analyze the above case, the model shows if deterioration rate, inflation and replenishment cost changes there is a very less impact upon the ordering quantity but heavy changes occur upon the total cost. Which is normally happen in day to day case due to inflationary situation and value of money decreases?

5. SENSITIVITY ANALYSIS

Sensitivity analysis of the model is also performed with respect to unit price of purchase, replenishment cost, inventory carrying cost, deteriorating cost, backordering cost, inflation rate, and stock dependent consumption rate. The model also judges the sensitive analysis of the parameters on ordering quantity and total system cost. Those results provided further insight in the nature of the problem studied. Table 2 summarizes these results.

TABLE - 2								
Variation in Parameter		% change value in parameter						
		-20	-10	-5	0	5	10	20
C₁	Q	38.89	36.034	34.056	33.16	32.35	30.69	28.11
	TC	681.95	685.12	688.35	689.15	691.25	694.31	698.23
C₂	Q	28.34	30.13	31.03	33.16	34.034	36.45	38.53
	TC	684.35	685.98	687.002	689.15	693.34	695.25	697.34
C₃	Q	33.95	33.85	33.75	33.16	32.06	31.35	30.23
	TC	685.23	686.25	688.005	689.15	688.80	687.15	686.01
C₄	Q	36.89	34.95	33.91	33.16	33.01	32.12	30.98
	TC	683.23	685.11	686.23	689.15	690.12	692.01	693.23
C₅	Q	30.11	31.58	32.11	33.16	35.29	37.23	39.65
	TC	681.19	684.98	685.12	689.15	695.23	698.99	701.22
K	Q	31.89	32.13	33.01	33.16	33.56	34.23	35.13
	TC	685.58	686.89	688.01	689.15	691.56	692.11	694.22
θ	Q	37.96	36.01	34.11	33.16	33.01	32.96	31.28
	TC	686.88	687.13	688.013	689.15	691.14	693.15	694.23
α	Q	30.69	31.58	32.88	33.16	34.12	35.23	36.11
	TC	640.012	647.56	656.23	689.15	692.89	695.23	697.29
r	Q	37.98	37.18	35.11	33.16	33.01	29.23	28.13
	TC	668.23	680.29	684.23	689.15	692.112	696.156	699.23

- i. Decrease in parameters like unit price (C_1), deterioration cost (C_4) and deterioration rate (θ) the optimal ordering quantity increases significantly and increase in the parameters, the optimal ordering quantity decreases and total system cost increases.
- ii. In case of decrease in parameters i.e. ordering cost (C_2), Shortage cost (C_5), Inflation rate (K) and constant of stock dependent consumption rate (α) the optimal ordering quantity decreases and total system cost also decreases.

- iii. In case of increase in parameters i.e. carrying cost (C_3) the optimal ordering quantity decreases and total system cost also decrease.
- iv. Decrease in parameters i.e. discount rate (r), the optimal ordering quantity increases significantly but decreases the total system cost.
- v. The values of the optimal ordering quantity vary from 28.11 to 38.89 and the optimal total system cost varies from 640.012 to 701.22 for 20% decrease or increase of all parameters.

6. CONCLUSIONS

In this study, we have proposed an inventory model under inflation for stock dependent consumption rate and exponential decay items with infinite replenishment rate with permitting shortages. This model can assist the manager in concisely determining the order size in the case of stock dependent consumption. The effect of the inflation rate, deterioration rate and stock depend on consumption rate are discussed. Numerical results show, that when parameter deterioration rate (θ) and discount rate (r) increase the optimal ordering quantity increases. However, when the parameter i.e. inflation rate (K) increases, the optimal ordering quantity increases and total system cost decreases. Moreover, parameter i.e. inflation rate (K), deterioration rate (θ) and discount rate (r) affect the optimal ordering quantity. Sensitivity analysis results demonstrate that the optimal ordering quantity is more sensitive towards parameters i.e. unit price (C_1), carrying cost (C_3) and discount rate (r) than other parameters. The proposed model can be used in inventory control of certain decaying items such as photographic

film, electronic components and radioactive materials which exhibit stock dependent consumption.

In a future study, the proposed model can further incorporate more realistic assumptions, such as probabilistic demand, trapezoidal fuzzy deterioration and shortage.

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