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An Inventory Model for Time Dependent Deteriorating Items and Holding Cost under Inflations When Vendor Credits To Order Quantity

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Abstract:- In this paper we discuss the possible affects of inflations by the supplier on a retailer's replanishment policy for time-dependent deteriorating items with constant demand rate. This optimal order quantity is obtained for all four cases i.e. for case 1, $0<T<T_d$, case 2, $T_d \leq T<M$, case 3, $T_d \leq M \leq T$ and case 4, $M\leq T_d <T$. The optimal total relevent cost is obtain for all these four cases which is minimum. Numerical result are used to illustrate the theoretical results.

Keywords:- constant demand, Inventory modal, Inflation, Order quantity, Time dependent deteriorating Items, Time dependent holding cost.

I. INTRODUCTION

In past few decades; inventory problems for deteriorating items have been studied in large scale. Most of physical goods deteriorate over time. In reality some of the items either decayed are not in a perfect condition to satisfy the demand. Food items, grasses, vegetables, fruits, drugs, pharmaceuticals, fashion goods and electronics substances are a few example of such items in which inefficient deteriorations can take place during the normal storage period of the units and this loss must be taken into account in the classification of the system.

The deterioration rate is an important factor of inventory in stock during the storage period, Ghare and Schrader [1] were the first proponents to establish a model for an exponentially deteriorating items. Ghare and Schrader's model was expended by Eovest and Philip [2] by taking constant deterioration rate to a two–parameter weibull distribution. Misra [3] developed an inventory model for optimal production lot-size model for a system with deteriorating inventory. An order-level lot-size inventory model for deteriorating items was discussed by Shah [4]. Hollier and Mak [5] developed inventory replenishment policies for deteriorating items in a declining market. Heng et al [6] extended misra's [3] and Shahi's [4] models to consider a lot-size, order-level inventory system with finite replenishment rate, constant demand rate and and exponential decay. Acomplete note on inventory literature for deteriorating inventory models was developed by Goyal and Giri [7] and Raafat [8]. Misra et al [9] developed an inventory model for weibull deteriorating itemswith permissible delay in payments under inflation. In paper [9] misra et al obtained the conditions for concavity of optimality. Later there are several interesting papers related to deteriorations such as Shah and Jaiswal [10], Aggarrwal [11] Hariga [12] and goyal and Giri [13], Dave and Patel [14] and Sachaan [15].

In most of the research papers mentioned above, the effects of inflation are not considered. However from a financial point of view, an inventory referents a capital investment and must complete with other assets for a firm's limited capital funds. Thus the effects of inflation can must be ignored is the study of inventory system. Misra [16], Buzacott [17], Bierman and Thomas [18] developed the inventory model under an inflationary conditions for the EOQ model. Liao et al [19] developed a model with deteriorating items under inflation when a delay in payment in permissible. Other related research papers are Chang [20], Brahmbhatt [21], Chandra and Bahner [22], Dattand pal [23], Moon et al [24], Gor and Shah [25], Huo [26] and othes.

In the present paper, an attempt has been made to develop a deterministic inventory model for time-dependent deteriorating items and time-dependent holding cost under inflation when supplier offers delay in payments. Shortages are not allowed. Rest of the paper organized as follows: In the next section proposed assumptions and notations are given following by mathematical formulation in section 3. Theoretical results are given in section 4. The numerical examples sensitivities are given in section 5. Finally, conclusions are given in the last section 6.

II. PROPOSED ASSUMTIONS & NOTATIONS

1. ASSUMPTIONS:

1.1 Replenishment is instantaneous
1.2 The demand is known and is constant.
1.3 The net discount rate of inflation is constant.
1.4 Shortages are not allowed.
1.5 Holding cost is time dependent i.e. h=h(t)=ht
1.6 If $Q<Q_d$ then the payment for the items received must be made.
1.7 If $Q\geq Q_d$ then the delay in payments up to M is permitted. During the trade credit period the account is not settled and generated sales revenue is deposited in an interest bearing account. At the end of credit period, the customer pays off all units ordered and starts paying for the interest charges on the items in stock.

2. NOTATIONS:
2.1 I(t) : Inventory level at any time t, $0\leq t \leq T$.
2.2 r : constant rate of inflation, $0< r < 1$.
2.3 h : holding cost per unit time i.e. h(t)=ht.
2.4 H : length of planning horizon and H = nT, where n is an integer for the number of replenishments to be made during period H and T is an interval of time between replenishments.
2.5 D : the demand rate per unit time.
2.6 $P(t) = pe^{rt}$: the selling price per unit time, p is the initial selling price at t=0.
2.7 $S(t) =se^{rt}$: the ordering cost per order at time t, s is the initial ordering cost at t=0.
2.8 $C(t) =ce^{rt}$: the purchasing cost at time t, c is the initial purchase price at t=0, c < p.
2.9 I_c : interest charged / \$ / year by the supplier per order.
2.10 I_d : the interest earned / \$ /year.
2.11 Q : order quantity.
2.12 Q_d : minimum order quantity for which the delay in payments is allowed.
2.13 T : the replenishment time interval.
2.14 T_d : the time interval that Q_d units are depleted to zero due to demand only.
2.15 Z(t) : the total relevant cost over (o, H).
2.16 θ : time dependent deteriorating items.

Note that the total relevant cost consists of (i) cost of placing order, (ii) cost of purchasing, (iii) cost of carrying inventory excluding interest charges, (iv) cost of interest charges for unsold items at t = 0 or after credit period M and (v) interest earned from sales revenue during the credit period.

III. MATHEMATICAL FORMULATION AND EQUATIONS

The rate of change of inventory with respect to time can be described by the following differential equation:

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

The solution of (1), with boundary condition I(t) = 0 is

$$I(t) = \left[D\left(T + \frac{\theta T^3}{6}\right) - D\left(t + \frac{\theta t^3}{6}\right)\right] . e^{\frac{-\theta t^2}{2}}, \quad 0 \leq t \leq T \tag{2}$$

And the order quantity is

$$Q = I(0) = DT + \frac{\theta D T^3}{6} \tag{3}$$

From the above equation (3) we can find the time interval in which Q_d units are depleted to zero due to demand only

$$\frac{Q_d}{D} = T_d + \frac{T_d^3 \theta}{6} \tag{4}$$

Hence it is easy to see that the inequality

$$Q < Q_d \text{ iff } T < T_d$$

Again the length of time intervals are all the same, hence we have

$$I(KT+t) = D\left[\left(T+\frac{\theta T^3}{6}\right) - \left(t+\frac{\theta t^3}{6}\right)\right].e^{\frac{-\theta t^2}{2}}, \quad 0 \le k \le n-1, \quad 0 \le t \le T \tag{5}$$

For total relevant cost in (0,H), we need following elements

(i) cost of placing order

$$S(0)+S(T)+S(2T)+ \dots\dots\dots\dots\dots\dots.+S\{(n-1)T\} = S\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{6}$$

(ii) cost of purchasing

$$Q[C(0)+C(T)+C(2T)]+ \dots\dots\dots\dots\dots + C\{(n-1)T\} = QC\left(\frac{e^{rH}-1}{e^{rT}-1}\right)$$
$$=CD\left(T+\frac{\theta T^3}{6}\right)\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{7}$$

(iii) cost of carrying inventory

$$\sum_{K=0}^{n-1} C(K,T)\int_0^T h(t).I(KT+t)dt = chD\left(\frac{e^{rH}-1}{e^{rT}-1}\right)\left(\frac{T^3}{6}+\frac{\theta T^5}{20}\right) \tag{8}$$

(iv) Regarding interest charged and earned, we have the following four possible cases based on the values of T, M and T_d

Case I, $0 < T < T_d$

Since $T < T_d$ (i.e. $Q < Q_d$). In this case the interest charges for all unsold items start at the initial time, we obtain the interest payable in (0,H) as

$$I_C \sum_{k=0}^{n+1} C(K,T) \int_0^T I(KT+t)dt = I_C cD\left(\frac{e^{rH}-1}{e^{rT}-1}\right)\left(\frac{T^2}{2}+\frac{\theta T^4}{8}\right) \tag{9}$$

$\therefore\ Z_1(T) =$ total cost in (0,H)

$$Z_1(T) = \left[s + cD\left(T+\frac{\theta T^3}{6}\right) + chD\left(\frac{T^3}{6}+\frac{\theta T^5}{20}\right) + I_C cD\left(\frac{T^2}{2}+\frac{\theta T^4}{8}\right)\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{10}$$

Case II, $T_d \le T < M$

In this case there is a permissible delay M which is longer than T. As a result there is no interest charged, but the interest earned in (0,H) is

$$I_d \sum_{k=0}^{n-1} P(K,T)\left[\int_0^T Dt\,dt + DT(M-T)\right] = I_d PD\left(\frac{e^{rH}-1}{e^{rT}-1}\right)\left(TM-\frac{T^2}{2}\right) \tag{11}$$

$\therefore\ Z_2(T) =$ total relevant cost in (0,H)

$$Z_2(T) = \left[s + cD\left(T+\frac{\theta T^3}{6}\right) + chD\left(\frac{T^3}{6}+\frac{\theta T^5}{20}\right) - I_d PD\left(TM-\frac{T^2}{2}\right)\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \tag{12}$$

Case III, $T_d \le M \le T$

In this case, T is longer than or equal to both T_d and M then delay in payment is permitted and the total relevant cost includes both the interest charged and the interest earned. The interest payable in (0,H) is

$$I_c \sum_{k=0}^{n-1} C(K,T) \int_M^T I(KT+t)dt$$
$$= I_C cD\left[\left(T+\frac{\theta T^3}{6}\right)(T-M)-(T-M)^2\left(\frac{1}{2}+\frac{\theta(T-M)^2}{24}\right)\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right) \quad (13)$$

The interest earned in (0,H) is

$$I_d \sum_{k=0}^{n-1} P(K,T) \int_0^M Dtdt = I_d pD\left(\frac{e^{rH}-1}{e^{rT}-1}\right)\left(\frac{M^2}{2}\right) \quad (14)$$

$\therefore\ Z_3(T) =$ total relevant cost in (0,H)

$$Z_3(T) = \left[s + cD\left(T+\frac{\theta T^3}{6}\right) + chD\left(\frac{T^3}{6}+\frac{\theta T^5}{20}\right)\right.$$
$$\left. + I_c cD\left\{\left(T+\frac{\theta T^3}{6}\right)(T-M)-(T-M)^2\left(\frac{1}{2}+\frac{\theta(T-M)^2}{24}\right)\right\} + I_d PD\left(\frac{M^2}{2}\right)\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right)$$

(15)

Case IV, $M \le T_d \le T$

In this case, the replenishment time interval T is also greater than or equal to both T_d and M. Hence case IV is similar to case III.

Thus total relevant cost in (0,H) is

$$Z_4(T) = \left[s + cD\left(T+\frac{\theta T^3}{6}\right) + chD\left(\frac{T^3}{6}+\frac{\theta T^5}{20}\right)\right.$$
$$\left. + I_c cD\left\{\left(T+\frac{\theta T^3}{6}\right)(T-M)-(T-M)^2\left(\frac{1}{2}+\frac{\theta(T-M)^2}{24}\right)\right\} + I_d PD\left(\frac{M^2}{2}\right)\right]\left(\frac{e^{rH}-1}{e^{rT}-1}\right)$$

(16)

IV. THEORETICAL RESULTS

Since inflation rate r is very small. Using truncated taylor's series expansion for the exponential terms, we get the modified (approximated) values of $Z_i(T)$,i=1,2,3&4 as follows

$$Z_1(T) = \frac{1}{r}\left[\frac{S}{T}+\left(\frac{chD\theta}{20}\right)T^4+\left(I_c cD\frac{\theta}{8}\right)T^3+(chD+cD\theta)\frac{T^2}{6}+(I_c cD)\frac{T}{2}+cD\right](e^{rH}-1) \quad (17)$$

$$Z_2(T) = \frac{1}{r}\left[\frac{S}{T}+\left(\frac{chD\theta}{20}\right)T^4+(cD\theta+chD)\frac{T^2}{6}+(I_d pD)\frac{T}{2}+(cD-I_d pDM)\right](e^{rH}-1) \quad (18)$$

$$Z_3(T) = \frac{1}{r}\left[\left(s-\frac{M^2}{2}-\frac{M^4\theta}{24}+\frac{I_d PDM^2}{2}\right)\frac{1}{T}+\left(\frac{chD\theta}{20}\right)T^4+\left(\frac{I_c cD\theta}{6}-\frac{\theta}{24}\right)T^3\right.$$
$$+\left(\frac{cD\theta}{6}+\frac{chD}{6}-\frac{I_c CD\theta M}{6}+\frac{\theta M}{6}\right)T^2+\left(I_c cD-\frac{1}{2}-\frac{\theta M^2}{2}\right)T$$
$$\left.+\left(cD-I_c cDM+M+\frac{\theta M^3}{6}\right)\right](e^{rH}-1) \quad (19)$$

$$Z_4(T) = \frac{1}{r}\Bigg[\left(s - \frac{M^2}{2} - \frac{M^4\theta}{24} + \frac{I_d PDM^2}{2}\right)\frac{1}{T} + \left(\frac{chD\theta}{20}\right)T^4 + \left(\frac{I_c cD\theta}{6} - \frac{\theta}{24}\right)T^3 + \left(\frac{cD\theta}{6} + \frac{chD}{6} - \frac{I_c CD\theta M}{6} + \frac{\theta M}{6}\right)T^2 + \left(I_c cD - \frac{1}{2} - \frac{\theta M^2}{2}\right)T + \left(cD - I_c cDM + M + \frac{\theta M^3}{6}\right)\Bigg](e^{rH} - 1) \tag{20}$$

The optimal solutions are obtained by taking the first and second order derivatives of $Z_i(T)$,i=1,2,3&4 with respect to T, we obtain

$$\frac{dZ_1(T)}{dT} = \frac{1}{r}\left[-\frac{S}{T^2} + \left(\frac{chD\theta}{5}\right)T^3 + \left(\frac{3I_c cD\theta}{8}\right)T^2 + (chD + cD\theta)\frac{T}{3} + \left(\frac{I_c cD}{2}\right)\right](e^{rH} - 1) \tag{21}$$

$$\frac{dZ_2(T)}{dT} = \frac{1}{r}\left[-\frac{S}{T^2} + \left(\frac{chD\theta}{5}\right)T^3 + (cD\theta + chD)\frac{T}{3} + \left(\frac{I_d pD}{2}\right)\right](e^{rH} - 1) \tag{22}$$

$$\frac{dZ_3(T)}{dT} = \frac{1}{r}\left[\left(-s + \frac{M^2}{2} + \frac{M^4\theta}{24} - \frac{I_d PD M^2}{2}\right)\frac{1}{T^2} + \left(\frac{chD\theta}{5}\right)T^3 + \left(\frac{I_c cD\theta}{2} - \frac{\theta}{8}\right)T^2 + (cD\theta + chD - I_c CD\theta M + \theta M)\frac{T}{3} + \right.$$
IccD−12−θM22 *erH−1* *(23)*

$$\frac{d^2Z_1(T)}{dT^2} = \frac{1}{r}\left[\frac{2S}{T^3} + \left(\frac{3chD\theta}{5}\right)T^2 + \left(\frac{3I_c cD\theta}{4}\right)T + \left(\frac{chD + cD\theta}{3}\right)\right](e^{rH} - 1) > 0 \tag{24}$$

$$\frac{d^2Z_2(T)}{dT^2} = \frac{1}{r}\left[\frac{2S}{T^3} + \left(\frac{3chD\theta}{5}\right)T^2 + \left(\frac{cD\theta + chD}{3}\right)\right](e^{rH} - 1) > 0 \tag{25}$$

$$\frac{d^2Z_3(T)}{dT^2} = \frac{1}{r}\left[\left(s - \frac{M^2}{2} - \frac{M^4\theta}{24} + \frac{I_d PD M^2}{2}\right)\frac{2}{T^3} + \left(\frac{3chD\theta}{5}\right)T^2 + \left(I_c cD\theta - \frac{\theta}{4}\right)T + (cD\theta + chD - I_c CD\theta M + \right.$$
θM13*erH−1>0* *(26)*

For optimal (minimum) solution, put $\frac{dZ_i(T)}{dT} = 0, i = 1,2,3,4,$ we obtain

$$\text{from (21)} \rightarrow \frac{dZ_1(T)}{dT} = 0$$
$$\rightarrow (24chD\theta)T^5 + (45I_c cD\theta)T^4 + 40(cD\theta + chD)T^3 + (60I_c cD)T^2 - 120s = 0 \tag{27}$$

$$\text{from (22)} \rightarrow \frac{dZ_2(T)}{dT} = 0$$
$$\rightarrow (6chD\theta)T^5 + 10(cD\theta + chD)T^3 + 15(I_d pD)T^2 - 30s = 0 \tag{28}$$

$$\text{from (23)} \rightarrow \frac{dZ_2(T)}{dT} = 0$$
$$\rightarrow (24chD\theta)T^5 + (60I_c cD\theta - 15\theta)T^4 + 40(cD\theta + chD - I_c cD\theta M + \theta M)T^3 + (120I_c cD - 60 - 20\theta M^2)T^2 - (120s - 60M^2 - 5M^2\theta + 60I_d pDM^2) = 0 \tag{29}$$

V. EXAMPLES AND TABLES

1.NUMERICAL EXAMPLES:

Case I, $0 < T < T_d$

Example 1. Let s=$ 150/order, c= $ 25/units, h=$ 2/unit/year, I_c =0.10/$/year, D=500 unit/year, p=$ 30 per unit, r=0.05 per unit, θ=0.02/unit/year, I_d=0.05/$ /year, H=1year, Substituting these values in (27) and (3) and (10) we get the values

T_1=0.23859 year and

Q_1=119.3176363 units

also

$Z_1(T)$ = $ 13855.3068

Case II, $T_d \leq T < M$

Example 2. let D= 100 units, θ=0.02, c= \$ 30/units, p=\$ 40 per unit, h=\$ 2/unit/year, I_d=0.05/\$ /year, H=1year, θ=0.02/unit/year, s=\$ 50/order, I_c =0.08/\$/year, r=0.05 per unit, M=110days, Substituting these values in (28) and (3) and (12) we get the values
T_2=0.275757 year and
Q_2= 27.5826897 units
also
$Z_2(T)$ = \$ 3306.058708

Case III, $T_d \leq M \leq T$
Example 3. let D= 100 units, θ=0.02, c= \$ 10/units, p=\$ 20 per unit, h=\$ 2/unit/year, I_d=0.05/\$ /year, H=1year, θ=0.02/unit/year, s=\$ 100/order, I_c =0.10/\$/year, r=0.05 per unit, M=90days, Substituting these values in (29) and (3) and (15) we get the values
T_3=0.489381 year and
Q_2= 48.9771679 units
also
$Z_2(T)$ = \$ 1343.472448

2. SENSITIVITY ANALYSIS:

Sensitivity analysis has been performed by considering various values of the parameters like unit ordering cost (s), unit purchasing cost (c), holding cost (h) and credit period (M), the corresponding values obtained with respect to the changes in above parameters are replenishment cycle time (T), economic order quantity Q and total relevant cost Z(T) by taking into consideration the following different cases.

i. When $0 < T < T_d$ [tables 1(a),1(b),1(c)]
ii. When $T_d \leq T < M$ [tables 2(a),2(b),2(c)]
Iii When $T_d \leq M \leq T$ [tables 3(a),3(b),3(c),3(d)]

Table 1. (case 1: When $0 < T < T_d$)

Table 1(a): Sensitivity analysis on ‘s’

s	T_1	Q_1	Z_1
150	0.23859	119.3176363	13855.3068
160	0.244222	122.1352775	13897.75343
170	0.249626	124.838925	13939.25126
180	0.254823	127.4390781	13979.87676
190	0.259831	129.9447362	14019.69635
200	0.264668	132.3648996	14058.76816

Table 1(b): Sensitivity analysis on ‘c’

c	T_1	Q_1	Z_1
25	0.23859	119.3176363	13855.3068
26	0.235227	117.6351925	14383.56674
27	0.232033	116.0373208	14911.47627
28	0.228993	114.5165131	15439.0561
29	0.226095	113.0667629	15966.32504
30	0.223328	111.6825643	16493.30019

Table 1(c): Sensitivity analysis on ‘h’

h	T_1	Q_1	Z_1
2.0	0.23859	119.3176363	13855.3068
2.1	0.235421	117.7322462	13867.30666
2.2	0.232421	116.2314255	13878.99609
2.3	0.229573	114.8066656	13890.39504
2.4	0.226865	113.4519604	13901.52142
2.5	0.224285	112.161304	13912.39143

Table 2. (case 2: When $T_d \leq T < M$) :

Table 2(a): Sensitivity analysis on ‘s’

s	T_2	Q_2	Z_2
50	0.275757	27.5826897	3306.058708
55	0.285129	28.52062686	3324.326745
60	0.29395	29.40346641	3342.020743
65	0.302295	30.23870813	3359.205202
70	0.310222	31.03215168	3375.932983
75	0.317781	31.78879701	3392.24809

Table 2(b): Sensitivity analysis on ‘c’

c	T_2	Q_2	Z_2
30	0.275757	27.5826897	3306.058708
32	0.270499	27.05649744	3516.208852
34	0.26563	26.56924756	3726.169845
36	0.261101	26.11603341	3935.958455
38	0.256872	25.69284975	4145.589172s

Table 2(c): Sensitivity analysis on ‘h’

h	T_2	Q_2	Z_2
2.0	0.275757	27.5826897	3306.058708
2.1	0.271813	27.18799406	3309.901882
2.2	0.268091	26.81552282	3313.638198
2.3	0.26457	26.46317306	3317.274924
2.4	0.261231	26.12904228	3320.818561
2.5	0.258058	25.81152837	3324.27495

Table 3. (case 3: When $T_d \leq M \leq T$)

Table 3(a): Sensitivity analysis on ‘s’

s	T_3	Q_3	Z_3
100	0.489381	48.9771679	1343.472448
110	0.505986	50.64178115	1364.303336
120	0.521641	52.21141446	1384.314229
130	0.536471	53.69856565	1404.020535
140	0.550576	55.11323276	1423.046035
150	0.56404	56.46381477	1441.589116

Table 3(b): Sensitivity analysis on ‘c’

c	T_3	Q_3	Z_3
10	0.489381	48.9771679	1343.472448
12	0.458144	45.84645419	1568.079531
14	0.433192	43.34629693	1790.415648
16	0.412604	41.28381419	2010.938256
18	0.395202	39.54077482	2230.042254

Table 3(c): Sensitivity analysis on ‘h’

h	T_3	Q_3	Z_3
2.0	0.489381	48.9771679	1343.472448
2.2	0.476678	47.7039039	1351.248941
2.4	0.465243	46.55786745	1358.644027

2.6	0.454867	45.51807127	1365.702524
2.8	0.445388	44.56825061	1372.461285
3.0	0.436676	43.69535599	1378.951003

VI. CONCLUSION

ANALYSIS OF THE RESULTS SHOWN IN TABLES 1 TO 3:

It is observed from the computational results shown in table 1(a) that for higher values of ordering cost ‘s’, the corresponding values of replenishment cycle time $T_{1,}$ order quantity Q_1 and total relevant cost Z_1 also go higher as per expectations and the table 1(b) indicate that with the increasing of unit purchasing cost ‘c’, the corresponding values of replenishment cycle time $T_{1,}$ order quantity $Q_1$are decreasing while the total relevant cost Z_1 is increasing with the increasing values of unit purchasing cost ‘c’ and the table 1(c) imply that the higher values of holding cost ‘h’ imply lower values of replenishment cycle time T_1 and order quantity Q_1but higher values of total relevant cost Z_1, the tendency of these results is the same as those shown in table 1(b).

The computational results obtained in table 2(a) indicate that ordering cost ‘s’ is directly proportional to the replenishment cycle time T_2, economic order quantity Q_2 and total relevant cost Z_2 i.e. an increase in ‘s’ implies the proportional increase in T_2, Q_2, Z_2 and in table 2(b) indicate that purchasing cost ‘c’ is inversely proportional to replenishment cycle time T_2 and economic order quantity Q_2 directly proportional to the total relevant cost Z_2 i.e. an increase in ‘c’ shows proportional decrease in T_2 andQ_2 while as increase in Z_2 and in table 2(c) indicate that higher values of holding cost ‘h’ are associated with the lower values of the replenishment cycle time T_2 and economic order quantity Q_2 and higher values of total relevant cost $Z_{2.}$

The computational results obtained in table 3(a) indicate that unit ordering cost ‘s’ is directly proportional to all the three values i.e. replenishment cycle time T_3 and economic order quantity Q_3 and total relevant cost Z_3 and 1n table 3(b) show that the value of replenishment cycle time T_3 and economic order quantity Q_3 decrease with the increasing of unit purchasing cost ‘c’ while total relevant cost Z_3 increase with the increasing values of unit purchasing cost ‘c’ and in table 3(c) indicate that higher values of holding cost ‘h’ imply the lower values of the replenishment cycle time T_3 and economic order quantity Q_3 and higher values of total relevant cost $Z_{3.}$

PROPOSED MODEL

The proposed model can be extended in many more ways such as, we can consider the demand rate in quadratic time dependent form. We can also consider the demand as a function of quantity or selling price. Further the shortages may also be taken in to account to generalize the model thus this paper can be useful developed as a wholesaler and retailer system model.

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