AN INVENTORY MODEL WITH THE EFFECT OF STOCK DEPENDENT DEMAND AND DETERIORATION UNDER SHORTAGE

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ABSTARCT

Decay or deterioration of physical goods while in stock is a natural phenomenon in many inventory systems. To reduce the amount of deterioration and the limited storage facility in own warehouse (OW) the retailer 's is moving their excess items to store in a rented warehouse (RW).In this investigation shortages are also allowed and partially backlogged. In this paper, considering all the factors stated above, we study two cases. Demand for both models is considering price-dependent and stockpile-dependent, while in first case we didn't consider shortages and in second case we consider as partially backlogged. Also we find the numerical example using the software Mathematica9.0

Key Words: Two warehouse, Deterioration, inflation, EOQ, Increasing holding cost, stockpile-dependent demand, partial backlogging.

1. Introduction :

Inventory model with deteriorating item such as seasonal products, volatile liquids, medicines, perfumes, etc. has been considered by various researchers in the few decades (Ghare and Scharder (1963)). In traditional models, researchers used to take constant demand. But in real market situation, this situation is very hypothetical. Demand may increase or decrease with time depending on various market situations. Bose, S., Goswami, A. and Chaudhuri, K.S. (1995) developed inventory model for deteriorating items with linear time–dependent demand rate, shortages under inflation and time discounting. Deterministic model of perishable inventory with stock dependent demand and non-linear holding cost was developed by Giri and Chaudhury (1998). Sett *et al.*(2012) discussed a two warehouse inventory model with increasing demand and a time-dependent deteriorating rate. Singh et al. (2013) proposed an optimal ordering policy for deteriorating items with power form stock dependent demand under two warehouse storage facilities. Kumar et al. (2001) developed a two warehouse inventory model for deteriorating items with three component demand rates and a time-proportional backlogging rate and fuzzy environment. The loss of inventory due to deterioration results in the financial loss which ultimately leads to an increase in the total cost significantly leads to an increase in the total cost significantly. In some situations, when situations ,when retailers purchases more goods than can be stored in their OW, retailers like to store excess items due to the capacity limitation in two warehouse (TW) instead of a single warehouse (SW) that is, may have to rent a warehouse. So Its all units ordered by the retailer in excess of the capacity of the OW or highly deteriorated items are to be kept at the rented warehouse. In our general life the practical experience tell that some but not every or all clients will wait in favor of backlogged merchandise for the shortage period for illustration such as for stylish merchandises and technologically advanced merchandises with the least living life cycle. If we increase the waiting time then the backlogging price will be decreased. Accordingly to this phenomenon we are taking to the backlogging price as an essential tool. Conversely the maximum of the inventory models is based on unrealistic suppose that when there is not stockpile either all demand lost or is backlogged. In the real situation, some customers due to goodwill or personal relation or by any mean are often willing to wait until the merchandise comes in stock especially if the waiting time is shortest whilst some others are irritated and go in a different place. The merchandise backlogging price depends on the replenishment time. In consideration of food merchandise, as milk merchandise, bread, green vegetables fruits packed merchandises etc. go down their effectiveness with increases of time.

Storage space conveniences are required to remain usable such types of merchandises from the deterioration. Into perform longer or greater luggage compartment period require some supplementary specialized machines and apparatus. Accordingly holding costs can't be unchanging of the total time period of storage and it increase when time increase. Warehouse is a commercial place or building used for the storage of goods. The goods can be row materials, spare parts, food stuffs, vegetables etc. This is a place where the inventory is stored until it is not seed or sold. Warehouse is planned time to time for filling the commodities. Sometimes we have purchase the items in bulk and there is need to store them for a time until they come in use.

In the present study we develop a model a two warehouse inventory model for increasing holding cost with the effect of stock dependent demand and deterioration under shortage.

In the recent study some author develop model with single storage capacity with constant holding cost and no deterioration and inflation. Some author develop model with stock dependent demand with constant deterioration with constant holding cost with no inflation. Some authors develop a two warehouse model with constant demand and deterioration with constant holding cost with shortages under inflation. But in the present study we develop a two warehouse inventory model with linearly price and stockpile dependent type demand with increasing holding cost with shortages under inflation.

2. Assumptions and Notations

The follow notations and assumption have been taken for developing the proposed model.

(i). The model is developed for only one deteriorating products with linearly price-and stockpile-dependent type demand as following pattern

$$D(p) = \begin{cases} \mathrm{a} - \mathrm{b}p + \alpha . q(t), & q(t) > 0 \\ \mathrm{a} - \mathrm{b}p \quad , & q(t) \leq 0 \end{cases} \quad \text{where } \mathrm{a} - \mathrm{b}p > 0$$

(ii).The rate of deterioration is taken as constant as well as is depends on level of stock.

(iii).Replacement and repair of damaged goods are not available for the period under consideration.

(iv).When the demand for goods is more than the supply Shortage will occur. Customer encountering shortage will either wait for the vender to reorder (backlogging cost involved) or go to other vendors. In this paper allowable shortage is consider under the rate of backlogging $[1+\delta(T-t)]^{-1}$, $(T-t)$ consider as waiting time and δ is positive constant for backlogging parameter.

(v) The per unit cycle holding cost is comparative for time period of the storage of every all unit and is to be comparative to the unit purchasing cost c. Not a dissimilar to all fares and Ghaithan (2016) developed a model taking holding Cost as function of two parts consisting as constant part g, and linearly increasing with shortage time part h respectively.

(vi).Unit of purchasing cost (c) in the discount era is not a continuous and decaying step function which depends on the total number of order quantity (M).

(vii).The OW has limited capacity of W units and the RW has the unlimited capacity. For economic reasons, the items of RW are consumed first and next the items of OW.

(viii). Period of deterioration in OW is larger than that of RW.

Ix. The inventory costs including holding cost and deterioration cost in RW are higher than those in OW.

(x). There is no replacement or repair of deteriorating items during the period under consideration

(xi).The goods of OW are consumed only after consuming the goods kept in RW.

(xii). Time and cost of transportation from RW to OW is ignored.

2.1 Nomenclature

Notations	Description
w	The capacity of OW
M	Initial inventory level at t = 0
θ_o	The deterioration rate at time t in OW
θ_r	The deterioration rate at time t in RW
$I_r(t)$	Inventory level of RW at time t (units)
$I_o(t)$	Inventory level of OW at time t (units)
A	The cost of replenishment is per order period.
a	The demand rate as Constant part for (a>0).
b	The demand rate for the Coefficient for the price in the (b>0).
c	The per unit Purchasing cost.
p	The per unit Selling price.
s	The per unit Shortage cost.
l	The per unit Opportunity cost
g	The Constant part for holding cost a fraction of unit purchase cost
h	Coefficient for linearly fluctuating keeping (holding) costs as a

	fraction of unit purchase costs.
I(t)	The Inventory level.
α	Demand rate parameter taken as Stock-dependent ($\alpha > 0$)
δ	Backlogging parameter
B	The initial number of inventories (with shortages model).
R	The greatest number of partially backlogging quantity for model including shortages.
M	The number of order quantity per replenishment cycle.
r	Rate of inflation
t_1	Time at which the stock ends (for model considering shortages)
T	Replenishment cycle length (for both models)
$TC_1(T)$	Total cost for model without shortages
$TC_2(T)$	Total cost for model with shortages

3. Model Formulation

In this study we assume a situation where a person associate with retailing purchase deteriorating merchandise as of its provider in a discounted environment with a purchasing cost per unit piece decreasing based upon the number of the quantity ordered.

First the Two warehouse model with no shortage in addition then Two warehouse model with partially backlogging also shortages will also be discuss underneath the circumstance of inflation when permissible delay in the payments is also allowed.

4. Mathematical Formulation

Case 1 Model without Shortages

In these particular cases an inventory level is taken as **M** at the time t = 0. Owing to the jointed special effects of demands the deterioration an inventory level will be zero at that time $t = T$ later than some time replenishment will be made for occupied inventory system and do again the entire inventory system (see Figure 1.) Therefore the level of inventory at a few instantaneous can be defined through the subsequent governing differential equation.

The governing differential equation describing the inventory level in interval [0, t_1].

In rented warehouse

$$\frac{dI_r}{dt} + \theta_r I_r(t) = -(a - bp + \alpha I_r(t))$$

$$\frac{dI_r}{dt} + \theta_r I_r(t) + \alpha I_r(t) = -(a - bp) \quad ,0< t < t_1 \quad \ldots(1)$$

With boundary condition at t = 0 , $I_r(0) = M - w$,t = t_1 , $I_r(t_1) = 0$

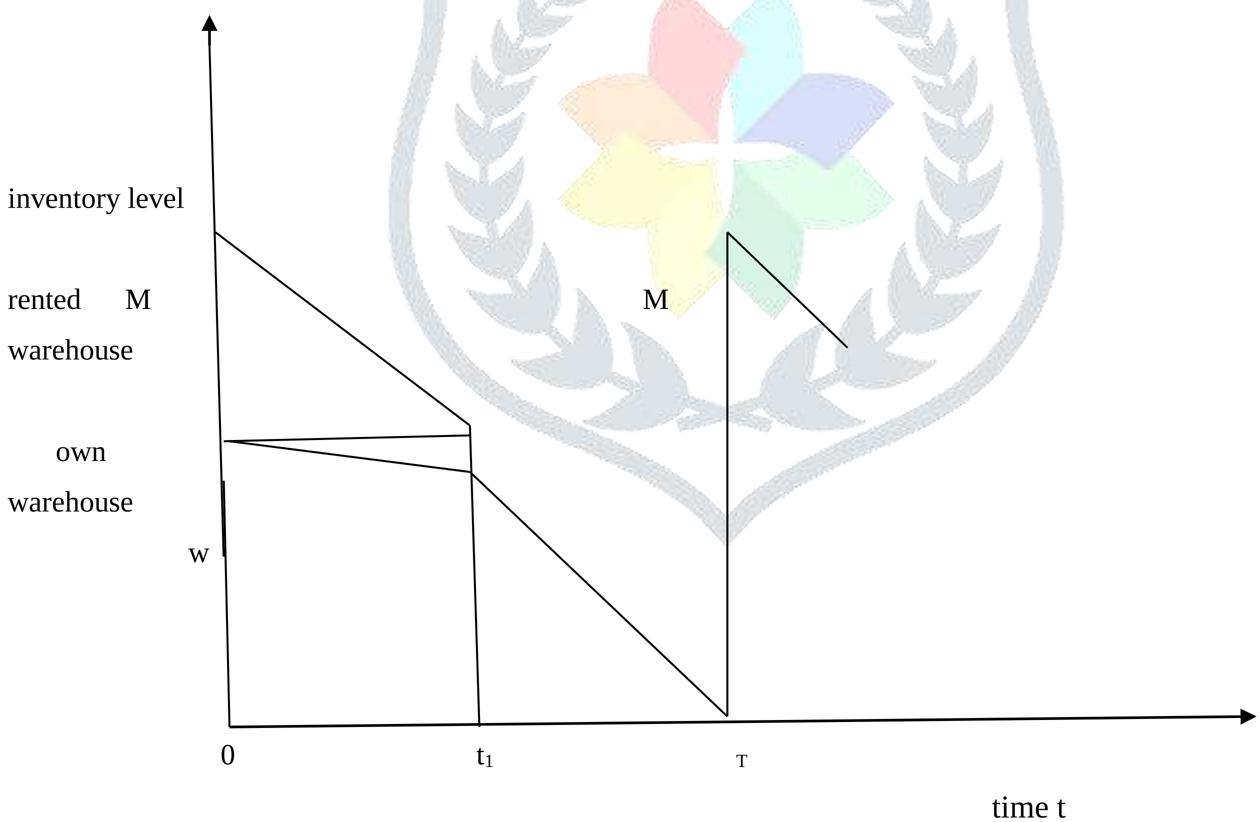


Diagram Representation of proposed model with no shortages allowed .

In own warehouse

$$\frac{dI_o}{dt} + \theta_o I_o = 0 \quad , 0< t < t_1 \quad \ldots\ldots(2)$$

With boundary condition at t = 0 , $I_0(0) = w$, t = t_1 , $I_o(t_1) = w - w_o$

The governing differential equation describing the inventory level in the interval $[t_1, T]$ is given by

$$\frac{dI_o}{dt} + \theta_o I_O = -[a - bp + \alpha I_o(t)]$$

$$\frac{dI_o}{dt} + \theta_o I_O + \alpha I_o(t) = -[a - bp] \quad ,t_1 < t < T \quad \text{.......(3)}$$

With boundary condition at t = t_1 , $I_o(t_1) = w - w_o$, at t = T , $I_o(T) = 0$

On solving the equation (1) we find the inventory level in interval [0,t_1] is given by

$$I_r(t) = \frac{N}{\eta_r}[e^{\eta_r(t_1 - t)} - 1] , \quad 0 < t < t_1 \quad \text{........(4)}$$

where $\eta_r = (\theta_r + \alpha)$ and N = a – bp

One can derive using the initial condition from equation (4)

$$M = w + \frac{N}{\eta_r}[e^{\eta_r t_1} - 1] \quad \text{........(5)}$$

On solving the equation (2) we find the inventory level in interval [0,t_1] is given by

$$I_o(t) = we^{\theta_o t} \quad 0 < t < t_1 \quad \text{........(6)}$$

One can derive using the initial condition from equation (5)

$$w = \frac{w_o}{(1 - e^{\theta_o t})} \quad \text{.........(7)}$$

On solving the equation (3) we find the inventory level in interval [0,t_1] is given by

$$I_o(t) = \frac{N}{\eta_o}[e^{\eta_o(T - t)} - 1] \quad t_1 < t < T \quad \text{.........(8)}$$

Where $\eta_o = (\theta_o + \alpha)$ and N = a-bp

Inventory cost for this model

Ordering cost = A ....(9)

Holding cost =

$$c\int_0^{t1}(g + ht)e^{-rt}I_r(t)dt + c\int_0^{t_1}(g + ht)e^{-rt}I_o(t)\,dt + c\int_{t_1}^{T}(g + ht)e^{-rt}I_o(t)\,dt$$

HC =

$$c(a - bp)\left[g\frac{t_1^2}{2} + h\frac{t_1^3}{6}\right] + c\left[g\left(t_1 - (r + \theta_o)\frac{t_1^2}{2} + h\left(\frac{t_1^2}{2} - (r + \theta_o)\frac{t_1^3}{3}\right)\right] + c(a - bp)\left[g\frac{T^2}{2} - g\left(Tt_1 - \frac{t_1^2}{2}\right) + h\frac{T^2}{6} - h\left(T\frac{t_1^2}{2} - \frac{t_1^3}{3}\right)\right]$$

........(10)

Purchasing cost = Cm = $c[w + \frac{(a - bp)}{(\theta_r + \alpha)}[e^{(\theta_r + \alpha)t_1} - 1]$ ....(11)

Hence total average cost for the inventory

$ATC_1 = \frac{1}{T}$ [Ordering cost + Holding cost + purchasing cost]

$$ATC_1 = \frac{1}{T}[A + c(a - bp)\left[g\frac{t_1^2}{2} + h\frac{t_1^3}{6}\right] + c\left[g\left(t_1 - (r + \theta_o)\frac{t_1^2}{2} + h\left(\frac{t_1^2}{2} - (r + \theta_o)\frac{t_1^3}{3}\right)\right] +$$

$$c(a-bp)[g\frac{T^2}{2}-g\left(Tt_1-\frac{t_1^2}{2}\right)+h\frac{T^2}{6}-h\left(T\frac{t_1^2}{2}-\frac{t_1^3}{3}\right)] + c[w+\frac{(a-bp)}{(\theta_r+\alpha)}[e^{(\theta_r+\alpha)t_1}-1]]$$

………(12)

Case 2 Model with shortage:

On commencement of the cycle order of $M=(R+S)$ units this piece comes into stockpile. Then the units are utilizing to meet a total accumulate backlogging demand resultant in an on-stockpile stock level of the S. The merchandises will be consumed to meet customer demand and spoil at the constant rate at some stage in the time interval. Owing to customer demand as well as resulting impact of decline the inventory level of the decreases to zero t $=t_1$. Shortly afterwards the shortages appears, which accumulates during period $[t_1, T]$ and depends on wait for time of a clients. At this time the new-fangled order is re-created as well as the entire system is replicated.

The performance of entire inventory system at full cyclic length is able to be shown in the Figure of 2. Then the position of the level of inventory i.e. $q(t)$ any time $t\in[0,T]$ which can be present via the subsequent differential equation as discussed follows:

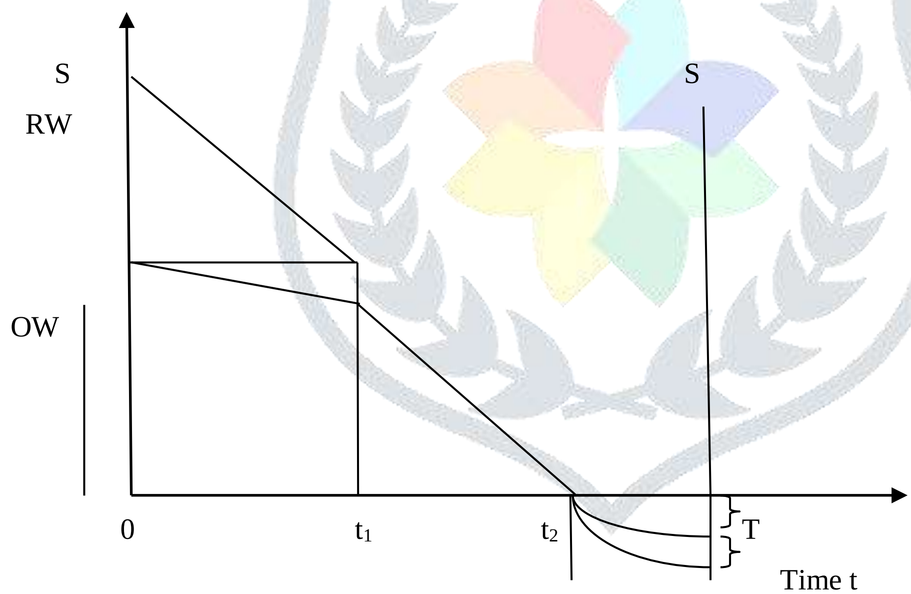


Fig. Graphical representation of purposed an inventory model with shortages.

The governing differential equation describing the inventory level in interval [0, t_1].

In rented warehouse

$$\frac{dI_r}{dt}+\theta_r I_r(t) = -(a-bp+\alpha I_r(t))$$

$$\frac{dI_r}{dt}+\theta_r I_r(t)+\alpha I_r(t) = -(a-bp) \qquad ,0< t < t_1 \qquad ………(1')$$

With boundary condition at t = 0, $I_r(0)=S-w$,t = t_1 , $I_r(t_1)=0$

In own warehouse

$\frac{dI_o}{dt}+\theta_o I_O=0$, 0< t < t_1 ………(2')

With boundary condition at t = 0, $I_0(0)=w$, t = t_1 , $I_o(t_1)=w-w_o$

The governing differential equation describing the inventory level in the interval $[t_1, t_2]$ is given by

$$\frac{dI_o}{dt}+\theta_o I_O=-[a-bp+\alpha I_o(t)]$$

$\frac{dI_o}{dt}+\theta_o I_O+\alpha I_o(t)=-[a-bp]$,t_1 < t < t_2 ……….(3')

With boundary condition at t = t_1 , $I_o(t_1)=w-w_o$, at t = t_2 , $I_o(t_2)=0$

The governing differential equation describing the inventory level in the interval $[t_2, T]$ is given by

$\frac{dI_o}{dt}=-\frac{(a-bp)}{[(1+\delta(T-t)]}$,t_2 < t < T ...……(4')

With boundary condition at t = t_2 , $I_o(t_2)=0$, at t = T , $I_o(T)=-R$

On solving the equation (1') we find the inventory level in interval [0,t_1] is given by

$I_r(t)=\frac{N}{\eta_r}[e^{\eta_r(t_1-t)}-1]$, 0< t < t_1 ……..(5')

where $\eta_r=(\theta_r+\alpha)$ and N = a – bp

One can derive using the initial condition from equation (4)

S = w $+\frac{N}{\eta_r}[e^{\eta_r t_1}-1]$ ……..(6')

On solving the equation (2') we find the inventory level in interval [0,t_1] is given by

$I_o(t)=we^{\theta_o t}$ 0< t < t_1 ……...(7')

One can derive using the initial condition from equation (7')

$w=\frac{w_o}{(1-e^{\theta_o t})}$ ………(8')

On solving the equation (3') we find the inventory level in interval [t_1,t_2] is given by

$I_o(t)=\frac{N}{\eta_o}[e^{\eta_o(t_2-t)}-1]$,t_1 < t < t_2 ………(9')

Where $\eta_o=(\theta_o+\alpha)$ and N = a-bp

On solving the equation (3) we find the inventory level in interval [t_2,T] is given by

$I_o(t)=\frac{(a-bp)}{\delta}\log[1+\delta(T-t)]-R$, t_2 < t <T ……(10')

One can derive using the initial condition from equation (10')

$R=\frac{(a-bp)}{\delta}\log[1+\delta(T-t_1)]$ ……(11')

The total counting ordering quantity at the very starting cycle is shown below

M = S+R

M = w + $\frac{(a-bp)}{(\theta_r+\alpha)}[e^{\eta_r t_1}-1]+\frac{(a-bp)}{\delta}\log[1+\delta(T-t_1)]$ …….(12')

Inventory cost for this chapter

Ordering cost = A ………(13')

Holding cost =

$$c\int_0^{t1}(g+ht)e^{-rt}I_r(t)dt + c\int_0^{t_1}(g+ht)e^{-rt}I_o(t)\,dt + c\int_{t_1}^{t_2}(g+ht)e^{-rt}I_o(t)\,dt$$

HC =

$$c(a-bp)\left[g\frac{t_1^2}{2}+h\frac{t_1^3}{6}\right]+c[g\left(t_1-(r+\theta_o)\frac{t_1^2}{2}+h\left(\frac{t_1^2}{2}-(r+\theta_o)\frac{t_1^3}{3}\right)\right]+ c(a-bp)[g\frac{t_2^2}{2}-g\left(t_2t_1-\frac{t_1^2}{2}\right)+h\frac{t_2^3}{6}-h\left(t_2\frac{t_1^2}{2}-\frac{t_1^3}{3}\right)]$$

…..(14')

Purchasing cost = c M = $c\,[w+\frac{(a-bp)}{(\theta_r+\alpha)}[e^{\eta_r t_1}-1]+\frac{(a-bp)}{\delta}\log[1+\delta(T-t_1)]$ …..(15')

Shortage cost (SC) = $-S\int_{t_2}^{T}e^{-rt}I_o(t)dt$

$$= \frac{-s(a-bp)}{r}[e^{-rt_2}(T-t_2)+\frac{(a-bp)+Rr}{(a-bp)r}(e^{-rT}-e^{-rt_2})]$$ ……(16')

Lost Sale cost (LSC) = $l\int_{t_2}^{T}(1-\frac{1}{(1+\delta(T-t_1))})(a-bp)e^{-rT}dt$

$$= \frac{l(a-bp)\delta}{r}[e^{-rt_2}\left(T-t_2+\frac{1}{r}\right)-\frac{1}{r}e^{-rT}]$$ …..(17')

Hence the total average cost function per unit is

$ATC_2 = \frac{1}{T}$ [Ordering cost +Purchasing cost +Holding cost + Shortage cost + Lost sale cost]

$$= \frac{1}{T}[A + c(a-bp)\left[g\frac{t_1^2}{2}+h\frac{t_1^3}{6}\right]+c[g\left(t_1-(r+\theta_o)\frac{t_1^2}{2}+h\left(\frac{t_1^2}{2}-(r+\theta_o)\frac{t_1^3}{3}\right)\right]+ c(a-bp)[g\frac{t_2^2}{2}-g\left(t_2t_1-\frac{t_1^2}{2}\right)+h\frac{t_2^3}{6}-h\left(t_2\frac{t_1^2}{2}-\frac{t_1^3}{3}\right)] + c[w+\frac{(a-bp)}{(\theta_r+\alpha)}[e^{\eta_r t_1}-1] + \frac{(a-bp)}{\delta}\log[1+\delta(T-t_1)]] - \frac{s(a-bp)}{r}[e^{-rt_2}(T-t_2)+\frac{(a-bp)+Rr}{(a-bp)r}(e^{-rT}-e^{-rt_2})] + \frac{l(a-bp)\delta}{r}[e^{-rt_2}\left(T-t_2+\frac{1}{r}\right)-\frac{1}{r}e^{-rT}]$$ ……..(18')

At this time the merchant objective to find out the optimal time for the positive inventory level. t_1^* Replenishment T^* for the order which to be minimizes the merchant the total cost per unit time. The retailer here aims to get the maximum period for the positive the level of inventory as well as replenish to reduce the seller total cost per unit time.

5. Numerical Illustration

5.1 Example Model without Shortages

Let us consider the follow illustration:

A=$150/Order, d_1=350, d_2=3, g=$2.1/unit, h=$2.3/unit, p=$3/unit, θ=0.01, r=0.6, c=$0.5/u.

We get T =5.9 and TC_1=8949.17 and t_1 =0.0097 years the Optimal solution for this model without shortages.

5.2 Example Model with Shortages

Let us consider the follow illustration:

A=$150/Order, d_1=350, d_2=3, g=$2.1/unit, h=$2.3/unit, p=$3/unit, θ=0.01, r=0.6, c=$0.5/unit, η=0.,

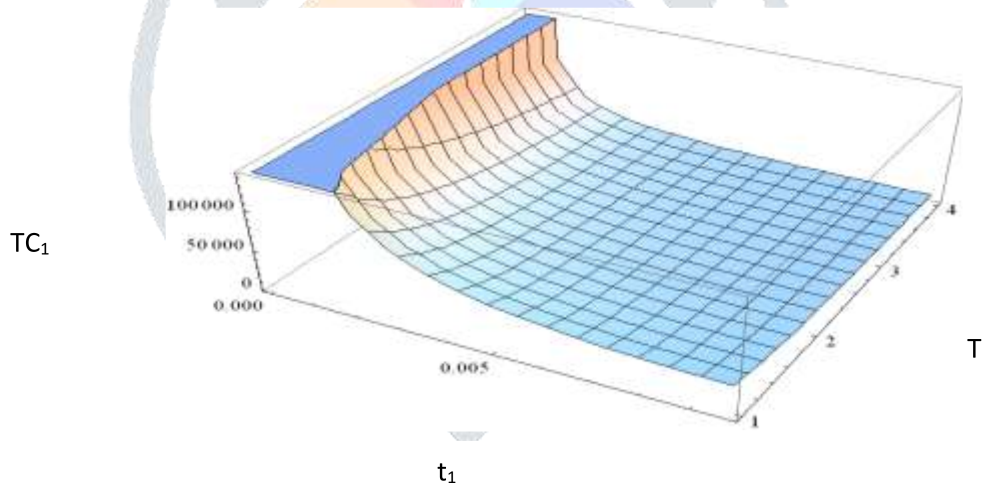
$\delta = .78, C_s = 40.5$ and $C_l = 32.6$, for the backlogged shortages.

Solution:

Optimal Total cost =1702 , T= 4 year and t_1= 2.1 year and t_2 = 3

Convexity

Graphical Representation of optimal cost for model



Sensitivity Analysis For different parameters without Shortage:

Table Sensitivity analysis for variations in holding cost (A)

A	Total Cost (TC_1)	Time (T)
+20%	8953.26	5.907
+15%	8951.99	5.906
+10%	8950.72	5.906
+5%	8949.45	5.905
0%	8949.17	5.9045
-5%	8946.91	5.9040
-10%	8945.64	5.9042
-15%	8944.37	5.9037
-20%	8943.1	5.9032

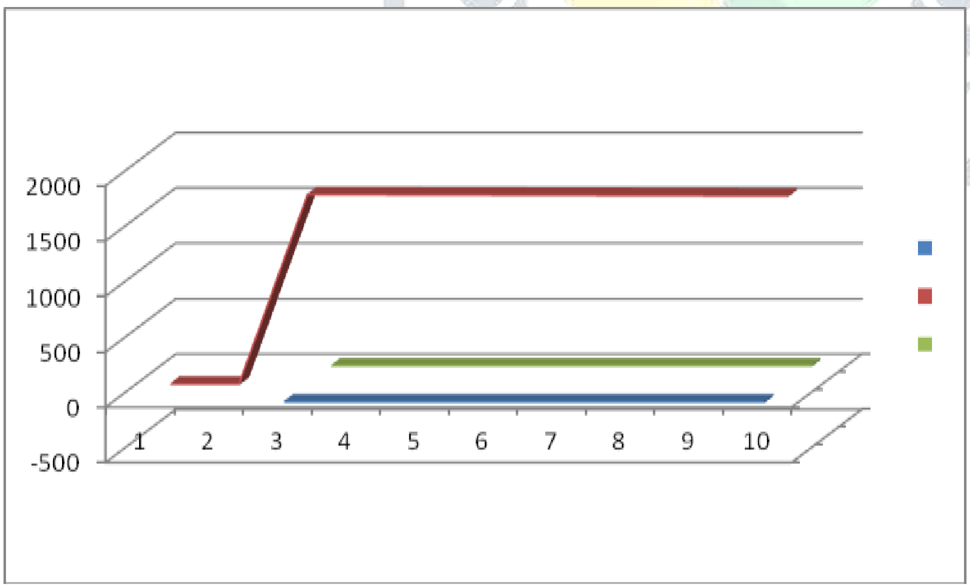
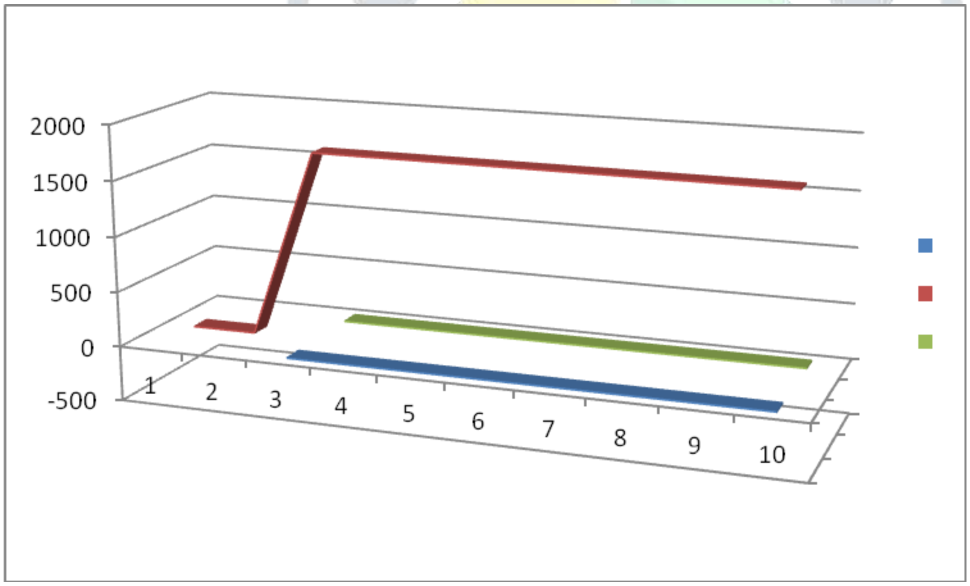


Table Sensitivity analysis for variations in coefficient of price in demand rate (b)

B	Total Cost (TC_1)	Time (T)
+20%	8901.06	5.905
+15%	8912.84	5.905
+10%	8924.62	5.9052
+5%	8936.4	5.9051
0%	8949.17	5.90
-5%	8959.96	5.90516
-10%	8971.74	5.90515
-15%	8983.52	5.90514
-20%	8995.29	5.90512



Sensitivity analysis for variations in constant part of holding cost (g)

G	Total Cost (TC_1)	Time (T)
+20%	9157.51	5.82721
+15%	9105.44	5.8465
+10%	9053.19	5.86592
+5%	90000.77	5.88548
0%	8949.17	5.9
-5%	8895.4	5.92501
-10%	8842.45	5.945
-15%	8789.32	5.96512
-20%	8736.01	5.98539

Table 2.9.1.4 Sensitivity analysis for time varying holding cost (h)

H	Total Cost (TC_1)	Time (T)
+20%	9380	5.59992
+15%	9276.24	5.67017
+10%	9169.81	5.7442
+5%	9060.53	5.82239
0%	8948.18	5.90517
-5%	8832.54	5.99305
-10%	8713.34	6.08661
-15%	8590.3	6.18652
-20%	8463.08	6.29362

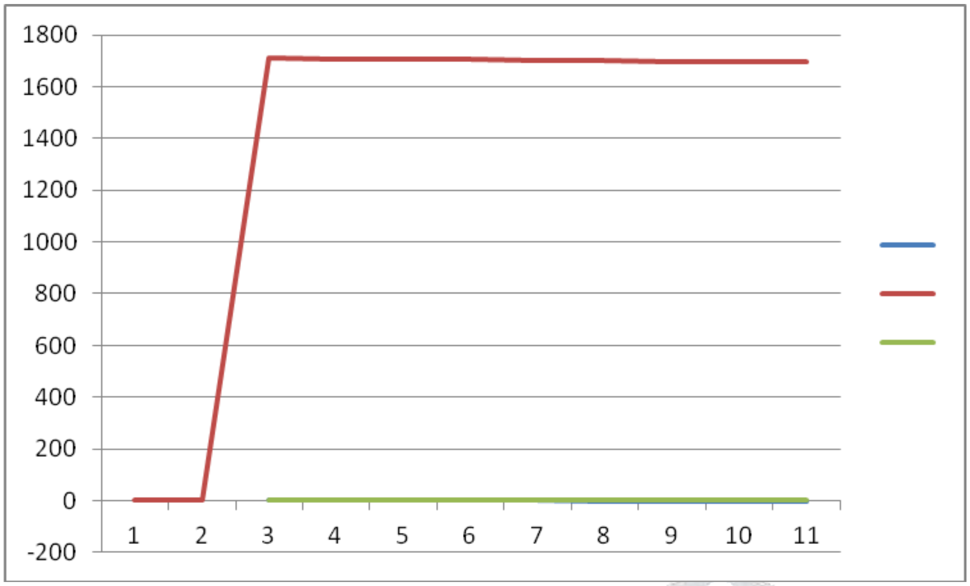
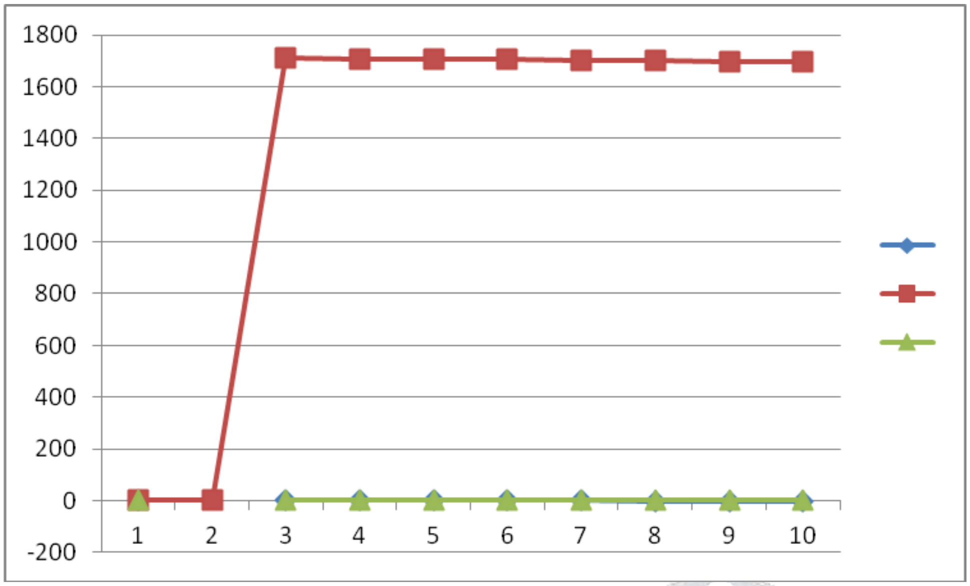


Table Sensitivity analysis for variations in inflation rate (r)

R	Total Cost (TC_1)	Time (T)
+20%	8731.26	5.8236
+15%	8781.07	5.84242
+10%	8833.63	5.86222
+5%	8889.22	5.8831
0%	8948.18	5.90517
-5%	9010.88	5.92857
-10%	9077.78	5.95345
-15%	9149.4	5.97999
-20%	9226.4	6.0084



For different parameters with shortages:

Table Sensitivity analysis for variations in holding cost (A)

A	Total Cost (TC_1)	Time (T)	Time(t_2)
+20%	1710.11	4	3
+15%	1708.3	4	3
+10%	1706.36	4	3
+5%	1704.48	4	3
0%	1702.61	4	3
-5%	1700.73	4	3
-10%	1698.86	4	3
-15%	1696.98	4	3
-20%	1695.11	4	3

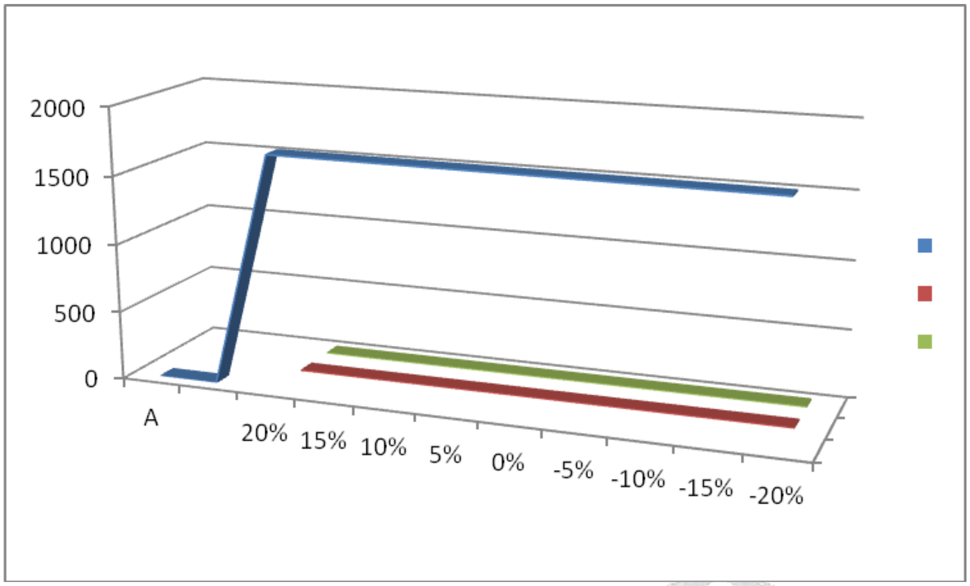


Table Sensitivity analysis for variations in coefficient of price in demand rate (b)

B	Total Cost (TC_1)	Time (T)	Time(t_1)
+20%	1693.9	4	3
+15%	1696.08	4	3
+10%	1698.25	4	3
+5%	1700.43	4	3
0%	1702.61	4	3
-5%	1704.78	4	3
-10%	1706.96	4	3
-15%	1709.14	4	3
-20%	1711.31	4	3

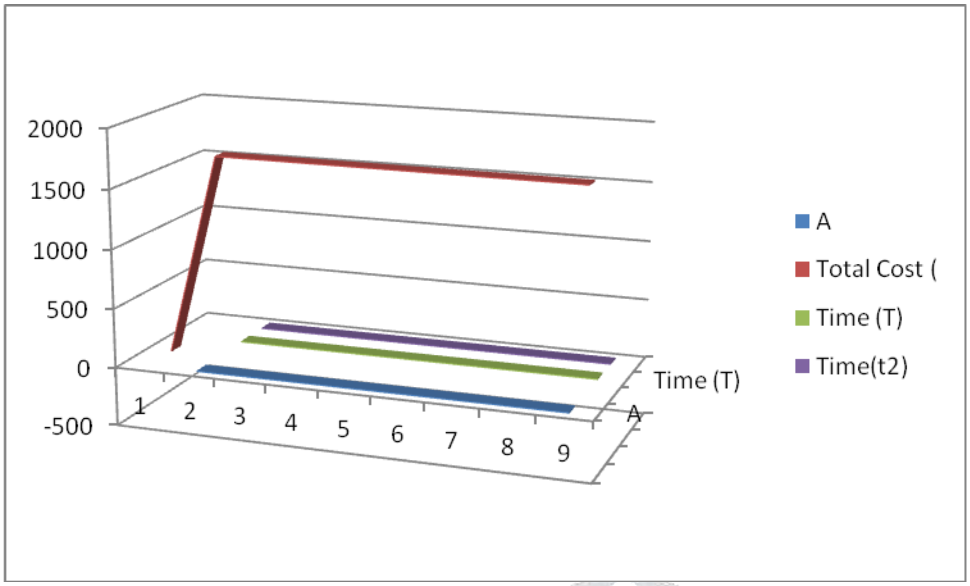


Table Sensitivity analysis for variations in constant part of holding cost (g)

G	Total Cost (TC_1)	Time (T)	(Time t_2)
+20%	-4701.07	$5.868*10^7$	1
+15%	1737.56	4	3
+10%	1725.97	4	3
+5%	1714.32	4	3
0%	1702.61	4	3
-5%	1690.83	4	3
-10%	1678.99	4	3
-15%	1667.07	4	3
-20%	1655.08	4	3

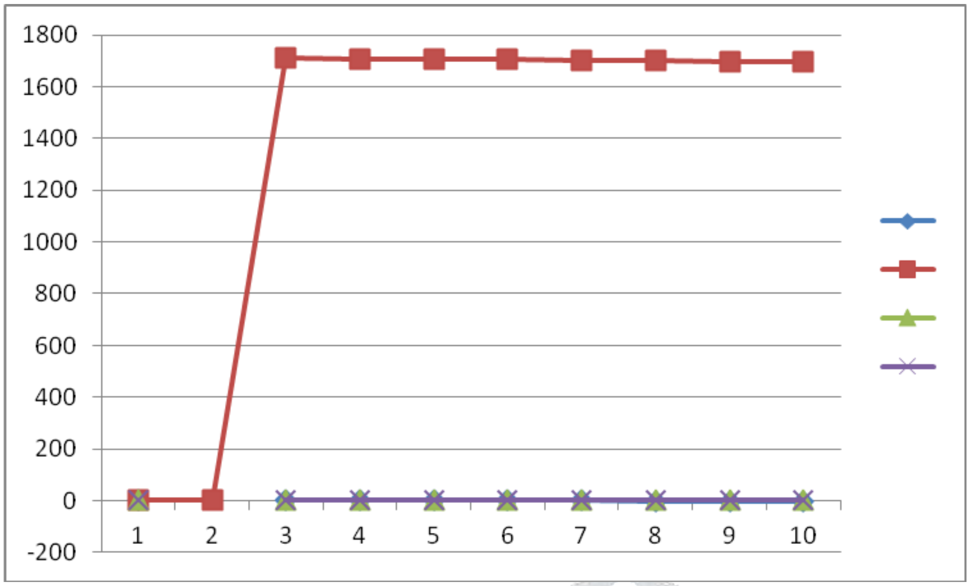


Table Sensitivity analysis for time varying holding cost (h)

H	Total Cost (TC_1)	Time (T)	Time(t_2)
+20%	1693.12	4	3
+15%	1695.5	4	3
+10%	-4701.07	$4.719*10^7$	1
+5%	1700.24	4	3
0%	1702.61	4	3
-5%	1704.96	4	3
-10%	1707.96	4	3
-15%	1709.66	4	3
-20%	1712	4	3

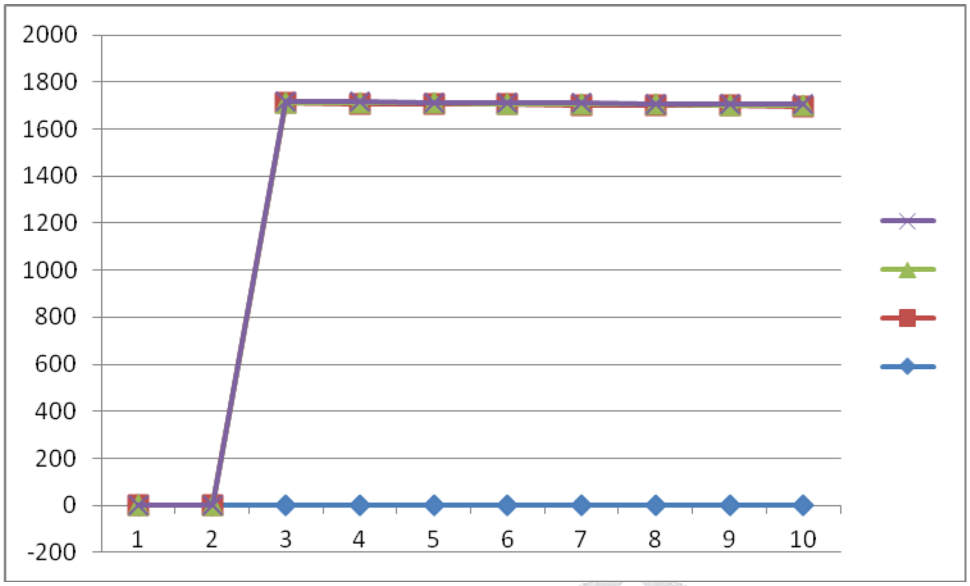
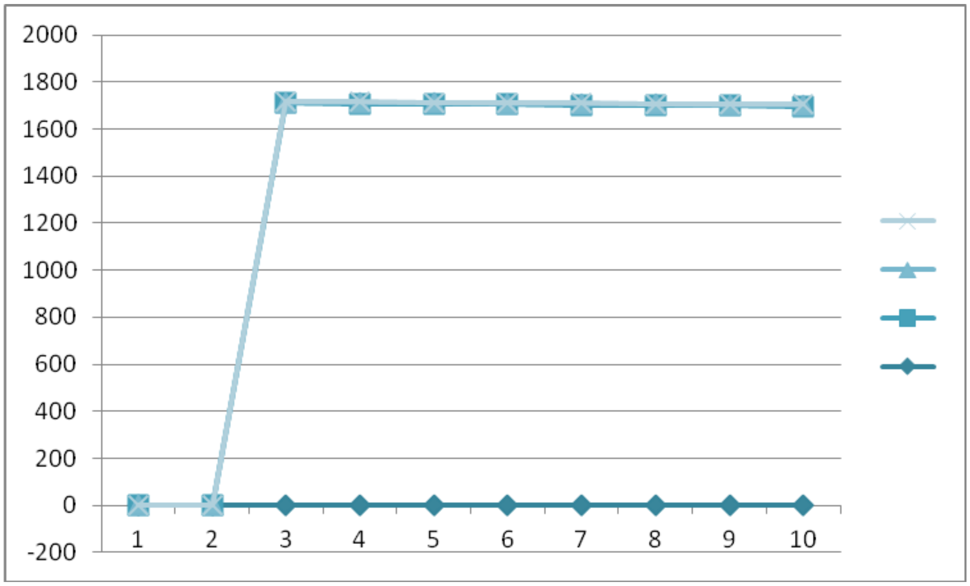


Table Sensitivity analysis for variations in inflation rate (r)

R	Total Cost (TC_1)	Time (T)	Time(t_2)
+20%	1155.34	4	3
+15%	1264.23	4	3
+10%	1389.68	4	3
+5%	1534.62	4	3
0%	1702.61	4	3
-5%	1897.97	4	3
-10%	2126.68	4	3
-15%	2393.6	4	3
-20%	2708.97	4	3



6. Observations: Sensitivity analysis is carried out here and the following observations made:

(i) Table (6.1.1) lists of the variation in the holding cost parameter ‘A’. It is observed from it table that with increment holding cost A value of critical time ‘T’ increases and value of the total Cost (TC_1) increases.

(ii) Table (6.1.2) lists the variations in coefficient of price in demand rate parameter ‘b’ increases value of critical time ‘T’ decrease and the value of Total Cost (TC_1) decreasing

(iii) Table (3) lists the variations in constant part of holding cost parameter ‘g’ increases value of critical time ‘T’ increases and value of the total Cost (TC_1) increases

(iv) Table (4) lists for the time varying holding parameter ‘h’ increases the value of critical time ‘T’ increases and value of the total Cost (TC_1) increases

(v) Table (5) lists for the variations in inflation rate parameter ‘r’ increases the value of critical time ‘T’ increases and value of the total Cost (TC_1) increases

7. Conclusion

In this study we have developed two inventory models(warehouse models) i.e. without shortages and with shortages which is partial backlogged with the realistic demand including varying carrying cost as well as unit purchase cost as variable underneath as order sizing base reduction environment for a seller viewpoint under the inflationary condition . It is also significant to mention that the inventory model is more economical including reduction in terms of cost optimization.

8. References

1. **Alfares, H.K., (2007)**, "Inventory model with stock level dependent demand rate and variable holding cost ", International journal of Production Economics 108,1-2,259-265.
2. **Alfares, H.K.,Ghaithan ,AM.,(2016)**, "Inventory and pricing model with price dependent demand , time varring holding cost and quantity discounts", Computers and Industrial Engineering 94 ,170-177.
3. **Aggarwal, S.P., & jaggi,C.K. (1995)**, "Ordering policies of deteriorating items under permissible delay in payments" Journal of the Operational Research Society,46,658-652.
4. **Buzakot, J.A. (1995)**, "Economic order quantities with inflation", Operational Research Quarterly .26,553-558.
5. **Bhunia, A.K., Maiti, M., (1994),** 'A two warehouse inventory model for a linear trend in demand', Opsearch, 31(4), 318-329.
6. **Hwang, &Son,K-Ik. (1983)**, "Management of deteriorating inventory under inflation", The Engineering Econmicst, 28,191-204.
7. **Jaggi, C.K., Verma, P., (2010),** 'Two-warehouse inventory model for deteriorating items with linear trend in demand and shortages under inflationary conditions', International Journal of Procurement Management, 3(1), 54-71.
8. **Yang,H-L.(2004)**, "Two warehouse inventory models for deteriorating items with shortages under inflation", European Journal of Operational Research , 157,344-356.
9. **Yang,H-L.(2006)**, "Two warehouse partial backlogging inventory model for deteriorating items under inflation", International Journal of Production Economics ,103,362-370.
10. **Zhou,Y.W.,& Yang, S-L.(2005)**, "A two warehouse inventory model for items with stock –level-dependent demand rate", International Journal of Production Economics,95,215-228.