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Innovative Study of EPQ Model with Time Induced Demand under Decline Release

Rakesh Prakash Tripathi [a,*] and Sachin Mishra [b]

[a] *Graphic Era (Deemed to be University), Dehradun, India*
[b] *Department of Applied Sciences and Humanities, KNIT, Sultanpur (UP) India*

Abstract: In this paper production, inventory (EPQ) model by means of incorporate cost diminution release strategy is considered. Production and demand both are simultaneous processes in the real world production and demand rate are considered time-linked. Two models (i) production inventory and (ii) manufacture inventory model in the midst of amalgamating cost decline delivery procedure are discussed. Mathematical formulations are provided to find optimal solution for both models. The objective of this study is to obtain optimal order measure to examine the outcome of lessening for cost release plan in the EPQ model. Best possible fabrication lot size model is developed that diminishes total cost. The sensitivity analysis is discussed for variation of different parameters.

Keywords: *Production; demand; Inventory; lot- size; reduction; total cost*

1. Introduction.

Inventory refers to commodities produced by an organization for forthcoming usage. An inventory processes is set of strategies and controls that monitors echelons of product, so that total cost per cycle is minimized for fair operations of industry. The predictability of demand insures the inventory model is deterministic, probabilistic or imprecise. Several factors involved for the demand of an inventory model like availability of materials, condition of market etc.Thus, decision maker cannot control the processors earlier decided by manager. In case of supply is more than demand shortages certainly occurred. Demand plays a deceive role is making inventory strategy. Large number of researchers have involved for developing several inventory models, considering the demand of items to be steady or time-induced. Time-induced demand inventory model is established by Dave (1986) and Maiti *et al.*((2009).Tripathi and Tomar [(2018) presented an economic order quantity (EOQ) model in favor of quadratic time- linked demand and holding cost in the company of salvage value. Khanra and Chaudhuri (2003) explored a model in favor of weakening products by time- associated demand pattern. Begum *et al* (2010) designed an inventory model by means of quadratic time unstable demand. Several research papers are published by Ghosh and Chandhuri (2004), Khanra *et al.* (2011), Amutha and Chandsekharan (2013), Tripathi *et al.*(2010), Kalam *et al* .(2010), Gour (2011), Shukla *et al* (2013), Tripathi *et al* (2014).

There are several economic production quantity (EOQ) models available in the literature. Bhownick and Samanta (2014) presented shortages linked inventory system where two different rates of productions are considered. Goswami and Chandhuri (1991) established an EOQ models for diminishing items by means of limited productions rate proportional to time-sensitive demand rate. A continuous production inventory model for worsening products under trade credit was developed by Kumar and Agarwal (2015), Agarwal (2015) studied a productions inventory model for exponential dependent demand and cost reductions delivery policy. Patel (2017) provided a productions inventory model for weakening objects with stock-level demand for different deterioration rates. Krishnamoorthy and Viswanath (2013) studied on (r, s) production inventory model in which the processing of inventory requires a positive random amount of time. Sarkar and Moon (2011) recognized a EPQ model for stochastic demand by means of the outcome of price rise. Goyal *et al*. (2003) designed an EPQ model for deficient quantity objects for spoiling commodities in the midst of trended demand and deficiency. Mandal and Ray (2004) pointed out a multi- product damaged manufacture lot size model by means of mixture figure cost constraints. Nobli *et al*. (2018) explored an EPQ model with and without shortages. Hsieh and Dye (2013) formulated a production-

Corresponding author email address: tripathi_rp0231@rediffmail.com

inventory model in favor of worsening substances by means of time- changing demand and restricted refill rate permitting conservation expertise cost as a pronouncement changeable in combination through production strategy. Several inventory models connecting with EPQ are studied by Poles (2013), Guchhail (2013), Das *et al* (2015), Ghiami and Williams (2015), Bouslah *et al* (2013) Noblesse (2014), Wee and Wang (1999), Zou *et al* (2003), Teng *et al* (2005), Nobil, *et al.* (2018), Chung *et al*. (2017), Bhunia *et al*. (2017), Pasandish *et al*. (2016), Saha and Chakrabarti (2018) , Chansamut *et al*. (2018).

Chen and Chen (2014) designed a fabrication inventory model for weakening articles by way of a multivariate demand function of worth and time. Lee and Hsu (2009) described a EPQ model over a predetermined setting up prospect for worsening objects by way of time-linked demand through ability restriction. Teng *et al*.(2014) proposed an EPQ model from the seller's probable to resolve his/her most advantageous trade credit epoch and fabrication lot size concurrently where (i) permitted delay period raises for sales and opening cost and defaulting hazard and (ii) production cost turns down and follow a erudition curve occurrence. Liu *et al.* (2015) considered a creation structure that can create various foodstuffs alternately, manufactured goods go during the scheme in a succession and a whole sprint of all products shapes a manufacture cycle and incorporated fabrication forms a defensive upholding model is built, which is distinguished by delay-time impression.

The remaining part of the article is framed as follows: In section 2 assumptions and notations are given. Section 3 offers EPQ model in two stages. In section 4, we establish mathematical formulation for model I. Section 5, 6, and 7 optimal solution, numerical example and sensitivity analysis are discussed respectively. Mathematical model for model 2 is discussed in section 7. Sections 8, 9 and 10 optimal solution, numerical example and sensitivity for model are given respectively. Conclusion is given in the last section.

2. Assumptions and Notations

2.1 Assumption

- Production and demand rates are time- sensitive
- Production rate is considered to be superior to demand rate
- Commodities are shaped & supplementary to the inventory
- Lead time is nil
- Shortages are not allowed
- Model is considered for single item

2.2. Notations

$D(t)= a + bt$: demand rate / unit time , a > 0 , 0 < b < 1
$P = P(t)$: Production rate/ unit time & $P(t) = \lambda D(t)$, $\lambda > 1$ (constant)
Q_1 : Inventory level during $[0, t_1]$
Q : Order quantity
Q^* : Optimal Q
C_p : Production cost/ unit
C_h : Holding cost/ unit/ year
K : Set up cost / set up
C_{FD} : Fixed delivery cost
C_H : Holding cost for dealer/ unit time
n : Number of release to clientele
P_c : Production cost
H_c : Holding cost
S_c : Set up cost
D_c : Fixed delivery cost /unit time
TC& TC^* : Total & optimal cost

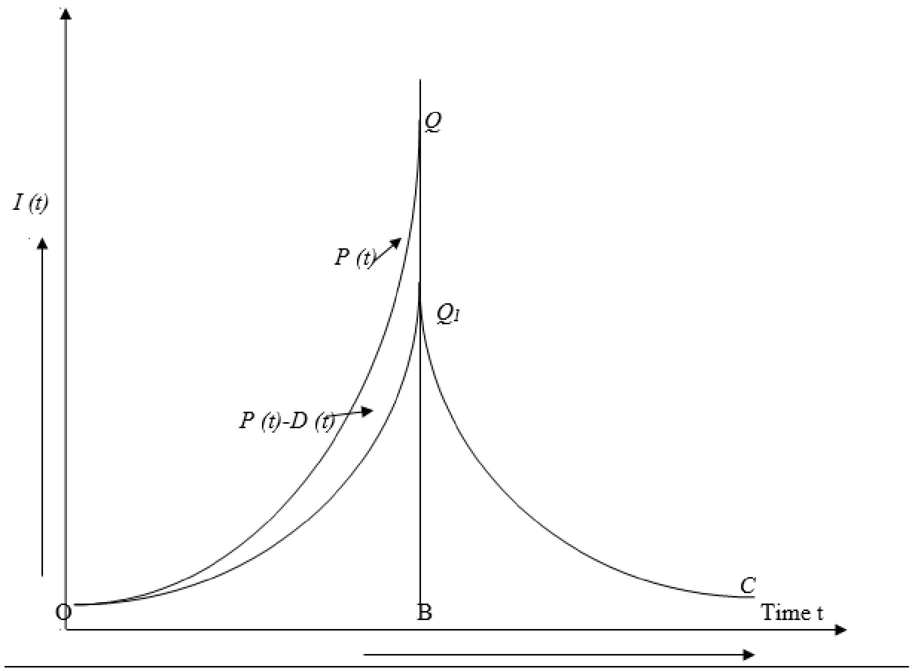

Figure 1. On hand Inventory for production and demand

3. Mathematical Formulation: Model 1. Production Inventory model

Production and demand rates occur simultaneously during the time [0, t_1]. Cycle begins at t = 0, inventory builds up by rate $P(t) – D(t)$. As a result, from region OBQ_1, we have

$$Q_1 = \int_0^{t_1} (\lambda - 1)(a + bt)\,dt = (\lambda - 1)\left(a + \frac{bt_1}{2}\right)t_1 \tag{1}$$

From Eq.(1), we get

$$b(\lambda-1)t_1^2 + 2a(\lambda-1)t_1 - 2Q_1 = 0$$

Or,

$$t_1 = \frac{-2a(\lambda-1) + \sqrt{\left\{4a^2(\lambda-1)^2 + 8bQ_1(\lambda-1)\right\}}}{2b(\lambda-1)} = \frac{\left\{2a^2(\lambda-1) - bQ_1\right\}Q_1}{2a^3(\lambda-1)^2} \text{, approximately} \tag{2}$$

Production stopped at Q_1. The only demand occurred from t_1 to $t_1 + t_2 = T$. Inventory level begins to diminish due to demand D (t). In the triangle BQ_1C

$$Q_1 = \int_{t_1}^{t_1+t_2} D(t)\,dt = \left(a + \frac{b}{2}t_2 + bt_1\right)t_2 \tag{3}$$

$$Q = \int_0^{t_1} P(t)\,dt = \int_0^{t_1} (a+bt)\,dt$$

$$t_1 = \frac{\sqrt{a^2 + 2bQ} - a}{b} \tag{4}$$

$$t_1 = \frac{Q}{a} - \frac{bQ^2}{2a^3} \quad \text{(Approximately)} \tag{5}$$

From Eq.(3) and (5), we get

$$t_2 = \frac{Q_1\left(a^2 - bQ\right)}{a^3} \quad \text{(Approximately)} \tag{6}$$

From Eqs. (2) and (4) , we get $\dfrac{\left\{2a^2(\lambda-1)-bQ_1\right\}Q_1}{2a^3(\lambda-1)^2} = \dfrac{Q}{a}-\dfrac{bQ^2}{2a^3}$

Or, $Q_1=\dfrac{\left(2a^2-bQ\right)(\lambda-1)Q}{2a^2}$ (7)

$T=t_1+t_2$

$$T=\frac{Q_1}{2a^3}\left[\frac{\left\{2a^2(\lambda-1)-bQ_1\right\}}{(\lambda-1)^2}+2(a^2-bQ)\right] \quad (8)$$

From Eq. (7) and (8), we get

$$T=\frac{\left(2a^2-bQ\right)Q}{8a^7}\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\} \quad (9)$$

Average inventory is given by

$$\bar{I}=\frac{Q_1(t_1+t_2)}{2T}=\frac{\left(2a^2-bQ\right)(\lambda-1)Q}{4a^2} \quad (10)$$

Total cost: In case of production process, total cost includes three main costs: such as S_c, P_c and H_c.

Set up Cost (S_c) $\dfrac{K}{T}=\dfrac{8a^7K}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}}$ (11)

Production Cost (P_c) $\dfrac{QP_c}{T}=\dfrac{8a^7P_c}{\left(2a^2-bQ\right)\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}}$ (12)

Holding Cost (H_c) $=\dfrac{C_h\left(2a^2-bQ\right)(\lambda-1)Q}{4a^2}$ (13)

Total Cost = Set up Cost + Production Cost + Holding Cost

$$TC=\frac{8a^7K}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}}+$$

$$\frac{8a^7P_c}{\left(2a^2-bQ\right)\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}}+\frac{C_h(\lambda-1)\left(2a^2-bQ\right)Q}{4a^2}$$

$$TC(Q)=\frac{8a^7(K+QP_c)}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}}$$

$$+\frac{\left(2a^2-bQ\right)(\lambda-1)QC_h}{4a^2} \quad (14)$$

4. Optimal Solution

Differentiating (14) partially w.r.t. Q and putting $\dfrac{dTC(Q)}{dQ}=0$,we get

$$32a^9 P_c Q\left(2a^2 - bQ\right) + 2(\lambda - 1)C_h Q^2\left(a^2 - bQ\right)\left(2a^2 - bQ\right)^2\left\{4a^4 - bQ\left(2a^2 - bQ\right) + 4a^2\left(a^2 - bQ\right)(\lambda - 1)\right\}\left\{4a^4 - bQ\left(2a^2 - bQ\right) + 4a^2\left(a^2 - bQ\right)(\lambda - 1)\right\} - 32a^9\left(K + QP_c\right)\left\{8a^4\left(a^2 - bQ\right) - 4bQ\left(2a^4 + b^2Q^2 - 3a^2bQ\right) + 4a^2(\lambda - 1)\left(2a^4 - 6a^2bQ + 3b^2Q^2\right)\right\} = 0 \quad (15)$$

Thus optimal Q^* can obtained from (15), TC will be minimum at Q^* if $\frac{d^2TC(Q)}{dQ^2} > 0$.However it is difficult to find $\frac{d^2TC(Q)}{dQ^2} > 0$, we will show it by graph.

5. Numerical Example

Let us consider the following parameter values, $a = 1000$, $b = 50$, $\lambda = 1.5$, $C_p = 100$, $K = 100$ units/year, $C_h = 10$ /units/year. Putting these values in Eqn(11), we obtain $Q^* = 12823.2$, and corresponding $TC = TC^*$ $= \$\ 209965.0$.

6. Sensitivity Analysis I

Variation of commodities is a natural phenomenon in the universe. Varying single constraint at a time and maintaining residual parameters identical as above example.

Table 1. Variation of *Q* & *TC* with *a*

a	Q	S_c	P_c	H_c	TC
1050	14084.6	13.9954	197120.0	23965.7	221100.0
1100	15398.9	13.3789	206021.0	26249.0	232283.0
1150	16765.3	12.8165	214872.0	28629.9	243515.0
1200	18182.6	12.3014	223672.0	31107.2	254792.0
1250	19649.8	11.8281	232420.0	33679.9	266111.0

Table 2. Variation of *Q* & *TC* with b

b	Q	S_c	P_c	H_c	TC
55	11735.2	16.1009	188947.0	19870.1	208834.0
60	10815.4	17.5291	189585.0	18265.5	207868.0
65	10027.9	18.9585	190114.0	16899.3	207032.0
70	9346.41	20.3887	190561.0	15722.4	206304.0
75	8751.07	21.8195	190944.0	14698.2	205664.0

Table 3. Variation of *Q* & *TC* with λ

λ	Q	S_c	P_c	H_c	TC
1.6	12019.6	15.059	181003.0	25223.5	206242.0
1.7	11297.4	15.471	174783.0	28373.2	203171.0
1.8	10624.7	15.9221	169167.0	31210.4	200394.0
1.9	9978.52	16.4284	163931.0	33701.6	197649.0
2.0	9342.95	17.0103	158926.0	35803.4	194747.0

Managerial Insights: From managerial point of view, following deduction can be prepared from the above tables. From Table 1: we see that increase of initial demand results increase in order quantity, production cost, holding cost and total cost while slightly decrease in setup cost. From Table 2, it is clear that increase of demand coefficient b leads increase in setup cost and cost while decrease order quantity, holding cost and total cost. From Table 3.we see that increase of λ results decrease in *Q*, P_c and *TC* and increase in *Sc* and H_c.

7. Model 2: Production inventory model with integrating cost and decline Release policy

This model integrates a cost delivery strategy. It is unspecified that completed objects can only be distributed to purchaser, if entire lot is assumed at the closing stages of manufacture time t_1.Permanent quantity of n completed article is delivered to customer t_2 for purchase of subordinating manufacturer's stock holding cost by means of rationale of dropping holding cost. Average inventory is given by

$$\bar{I} = \frac{Q_1}{2T}\left\{t_1 + \left(\frac{n-1}{n}\right)t_2\right\} = \frac{\left(2a^2-bQ\right)\left(\lambda-1\right)Q\left\{4a^4n - bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}}{4a^2n\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{16}$$

In this model *TC* consists of

$$\text{Set up Cost} = \frac{K}{T} = \frac{8a^7K}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{17}$$

$$\text{Production Cost} = \frac{QP_c}{T} = \frac{8a^7QP_c}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{18}$$

$$\text{Holding Cost} = \frac{C_H}{T}\left(\text{Average inventory}\right)$$

$$= \frac{C_H\left(2a^2-bQ\right)\left(\lambda-1\right)Q\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}}{4a^2n\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{19}$$

$$\text{Fixed Delivery Cost } (C_{FD}) = \frac{1}{T}nD_c = \frac{8a^7nD_c}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{20}$$

$$\text{Stock holding cost for buyer} = \frac{C_HQ_1t_2}{2nT} = \frac{C_H\left(\lambda-1\right)^2Q\left(a^2-bQ\right)\left(2a^2-bQ\right)}{n\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{21}$$

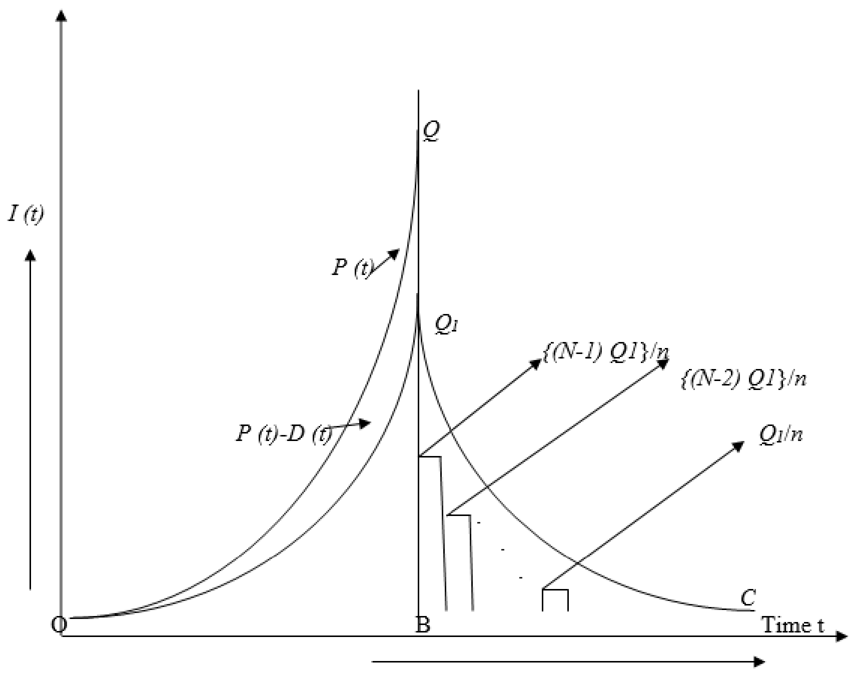

Figure 2. Inventory with integrates cost decline release policy

$$TC=\frac{8a^7\left(K+QP_c+nD_c\right)}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}}+$$

$$C_H\left(2a^2-bQ\right)\left(\lambda-1\right)Q\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}$$

$$+\frac{\left\{4a^2C_H\left(\lambda-1\right)^2Q\left(a^2-bQ\right)\left(2a^2-bQ\right)\right\}}{4a^2n\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{22}$$

8. Optimal Solution: Differentiating partially Eq$^{n.}$ (22) w.r.t. Q, we get

$$\frac{\partial TC\left(Q,n\right)}{\partial Q}=4a^2n\left(2a^2Q-bQ^2\right)\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}$$

$$\left\{32a^9nP_c+16a^2n\left(\lambda-1\right)QC_H\left(2a^4+b^2Q^2-3a^2bQ\right)-\ 6bn\left(\lambda-1\right)C_H\left(4a^6-b^3Q^3-8a^4bQ+5a^2b^2Q^2\right)+\right.$$

$$\left.4a^2\left(\lambda-1\right)^2\left(n-1\right)C_H\left(2a^4-6a^2bQ+3b^2Q^2\right)+4a^2C_H{}^2Q\left(\lambda-1\right)^3\left(8a^6+20a^2b^2Q^2-24a^4bQ-5b^3Q\right)\right\}-$$

$$\left\{32a^9n\left(K+QP_c+nD_c\right)+C_HQ^2\left(\lambda-1\right)\left(2a^2-bQ\right)^2\right\}$$

$$\left\{8a^4\left(a^2-bQ\right)-4bQ\left(2a^4+3b^2Q^2-3a^2bQ\right)+4a^2\left(\lambda-1\right)\left(2a^4-6a^2bQ+3b^2Q^2\right)\right\}$$

$$\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)+4a^2C_H\left(\lambda-1\right)^2Q\left(a^2-bQ\right)\left(2a^2-bQ\right)\right\}$$

$$\left\{8a^4\left(a^2-bQ\right)-4bQ\left(2a^4+b^2Q^2-3a^2bQ\right)+4a^2\left(\lambda-1\right)\left(2a^4-6a^2bQ+3b^2Q^2\right)\right\} \tag{23}$$

Differentiating Eq^{n}. (20) partially w.r.t. n two times , we get

$$\frac{\partial TC}{\partial n}=\frac{8a^7D_c}{\left(2a^2-bQ\right)Q\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}}+\frac{C_HQ\left(\lambda-1\right)\left(2a^2-bQ\right)}{4a^2n}$$

$$+\frac{C_H\left(2a^2-bQ\right)\left(\lambda-1\right)Q\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}}{4a^2n^2\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}}$$

$$+\frac{4a^2C_H\left(\lambda-1\right)^2Q\left(a^2-bQ\right)\left(2a^2-bQ\right)}{4a^2n^2\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}}$$

$$+32a^9D_cn^2+C_HQ^2n\left(2a^2-bQ\right)^2\left(\lambda-1\right)\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}+$$

$$\left(2a^2-bQ\right)Q\left[C_H\left(2a^2-bQ\right)\left(\lambda-1\right)Q\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}\right.$$

$$\left.+4a^2C_H\left(\lambda-1\right)^2Q\left(a^2-bQ\right)\left(2a^2-bQ\right)\right] \tag{24}$$

$$\frac{\partial^2\{TC\}}{\partial n^2}=\frac{C_H(2a^2-bQ)(\lambda-1)Q\left[\left\{4a^4n-bQn\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(n-1\right)\left(a^2-bQ\right)\right\}\right]}{2a^2n^3\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2\left(\lambda-1\right)\left(a^2-bQ\right)\right\}} \tag{25}$$

$$+\frac{2C_H(\lambda-1)^2 Q\left(a^2-bQ\right)\left(2a^2-bQ\right)}{n^3\left\{4a^4-bQ\left(2a^2-bQ\right)+4a^2(\lambda-1)\left(a^2-bQ\right)\right\}} \tag{26}$$

Optimal Q & n is obtained by solving

$$\frac{\partial TC(Q,n)}{\partial Q}=0 \ \& \ \frac{\partial TC(Q,n)}{\partial n}=0 \text{ , simultaneously} \tag{27}$$

Putting (21) and (23) equal to zero, we get (25).

$Q*$ and $n*$ will be minimum if $\frac{\partial^2 TC(Q,n)}{\partial Q^2}>0$ & $\frac{\partial^2 TC(Q,n)}{\partial n^2}>0$, but it is difficult to find the second order derivative with respect to Q and n positive. We can show it by graph (Fig. 3 and 4 respectively). Putting (21) and (23) equal to zero, we get (27).Solving equations (27) simultaneously for Q and n, we get optimal values of Q and n.

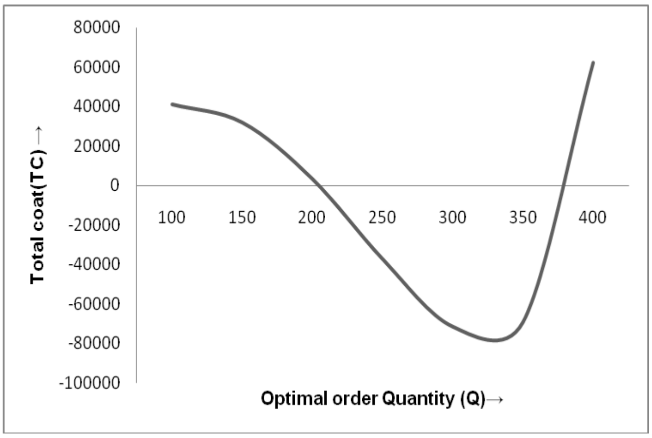

Figure 3. Graph between Order quantity (Q) and Total cost (TC)

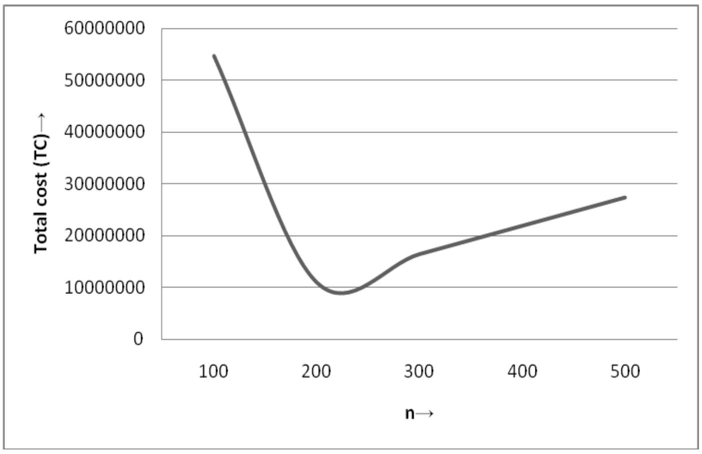

Figure 4. Graph between delivery number (n) and Total cost (TC)

9. Numerical Example

Let us consider the parameter values.

$a=45$ unit/ year , $b=10$ unit /year , $\lambda=1.5$, $P_c=10$ \$/ year , $K=10$ units/year, C_h =10/units/year, $C_H=5$ \$/ year , $D_c=2$ \$/ year.

Solution: Solving the simultaneous equations (21) and (23) by Mathematica Software $Q = 404.997$, $n = 0.0055417$, Set up Cost (Sc)= 300002.0 $/ year, Production Cost (P_c) $=1.215X10^8$ \$/year , Holding Cost (H_c) $= 0.272169$ \$/year , Fixed Delivery Cost (C_{FD}) =332.504 $/ year, Stock Holding Cost for Suppliers $= -0.676673$ \$/year , Total Cost (TC) $=1.218X10^8$ \$/year .

10. Sensitivity analysis II

Variation is the natural phenomena of all most all commodities in the university

Table 4. Variation of Q , n , S_c , P_c , H_c , D_c, C_{FD} and TC with a

a	Q	n	S_c	P_c	H_c	C_{FD}	TC
50	250.0	0.00049801	5.3334	1333.34	0.00024867	0.000531	1752.84
55	302.5	0.00045305	4.8485	1466.67	0.00022627	0.000439	2023.36
60	360.5	0.00041551	4.4486	1603.71	0.00020756	0.000370	1824.97
65	422.5	0.00038371	4.1026	1733.33	0.00019170	0.000315	2650.69
70	490.5	0.00035642	3.8122	1869.84	0.00017809	0.000272	2430.52

Table 5. Variation of Q , n , S_c , P_c , H_c, D_c, C_{FD} and TC with b

B	Q	n	S_c	P_c	H_c	C_{ED}	TC
15	135.0	0.0005514	8.88893	1200.0	0.00027504	0.0009804	1359.36
20	101.3	0.0005501	11.8519	1200.0	0.00027413	0.0013039	1361.49
25	81.00	0.0005487	14.8149	1200.0	0.00027322	0.0016258	1329.68
30	67.50	0.0005473	17.7779	1200.0	0.00027231	0.0019460	1317.02
35	57.89	0.0005459	20.7409	1200.0	0.00027140	0.0022647	7599.04

Table 6. Variation of Q , n , S_c , P_c , H_c , D_c, C_{FD} and TC with λ

λ	Q	n	S_c	P_c	H_c	C_{FD}	TC
1.6	202.5	9.6×10^{-4}	225001.0	9.11244×10^{7}	0.47291	0.0011322	1832.1
1.7	202.5	1.5×10^{-3}	249999.0	1.01248×10^{8}	0.64864	0.0001798	2366.6
1.8	202.5	2.3×10^{-3}	281239.0	1.13900×10^{8}	1.13413	0.0002684	3185.9
1.9	202.5	3.2×10^{-3}	409013.0	1.65646×10^{8}	2.76613	0.0003821	4278.2
2.0	202.5	4.4×10^{-3}	1.08×10^{9}	4.36739×10^{11}	9134.93	0.0005242	6041.2

Managerial Insights: From managerial point of view following deduction can be prepared from the above tables.
From Table 4, we see that enlarge of 'a' results increase of Q , S_c, P_c , C_{FD} and decrease in n and H_c.
From Table 5, we see that, increase of b results decrease in Q , n , Sc , C_{FD} , and fluctuation in P_c and TC.
Table 6, indicates that increase of λ leads no variation in Q, increase in n , H_c and C_{FD} and fluctuation in S_c , P_c and TC.

11. Conclusion and Future Research

Production and demand both are spontaneous and continuous processes for for both the buyer and the vendor**.** In this paper, we have discussed the manufacture inventory model for time-linked production and demand rates and integrated cost diminution delivery policy into a production inventory model. Mathematical formulations have been established for finding optimal solution. Numerical illustrations are given to demonstrate the practical usages. Sensitivity investigations are discussed with the variation of different parameters.

The research work presented in this study can be extended for time sensitive deterioration as well as Weibull deterioration. We can also generalize the model considering exponential demand, freight charges and advertisement cost and others

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