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ECONOMIC PRODUCTION MODEL WITH RELIABILITY AND INFLATION FOR DETERIORATING ITEMS UNDER CREDIT FINANCING WHEN DEMAND DEPENDS ON STOCK DISPLAYED

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ABSTRACT
Maintaining inventory for perishable products is a challenge for retailer's, while determining the production rate to minimize the total cost function. This model deals with stock-dependent demand for partial trade credit policy under reliability and inflation. The model uses a classical optimization method to solve the inventory problem. The intent is to compute the total cost function with respect to production time. At last, with the help of numerical example sensitivity analysis is done, related to different inventory parameters by keeping one parameter constant at a time and changing others.

KEYWORDS: Stock-dependent demand, Deterioration, partial trade credit, reliability, inflation, sensitivity

MSC: 90B05

RESUMEN
Mantener el inventario de productos perecederos es un desafío para los minoristas, al mismo tiempo que se determina la tasa de producción para minimizar la función de costo total. Este modelo se ocupa de la demanda dependiente de las existencias de una política de crédito comercial parcial en condiciones de confiabilidad e inflación. El modelo utiliza un método de optimización clásico para resolver el problema de inventario. La intención es calcular la función de costo total con respecto al tiempo de producción. Por último, con la ayuda de un ejemplo numérico se realiza un análisis de sensibilidad relacionado con diferentes parámetros de inventario manteniendo un parámetro constante a la vez y cambiando otros.
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1. INTRODUCTION

Economic production quantity model basically focuses on the manufacturing rate of optimum order quantity to reduce the unnecessary financial loss. The EPQ model is being used by many companies and organizations to determine what must be the production rate that helps to condense the retailers cost function. In the inventory system, product demand plays a vital role. It may be constant or dependent on

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certain factors like stock-level, selling price, time-dependent or quality. To compare the model with a realistic situation, the paper deals with stock-dependent demand under constant manufacturing rate as large volume offers variation and quality that help to accelerate the consumption rate. The EPQ model studies perishable products that deteriorate with time. Deterioration refers to the decay and damage that occurs with time resulting in loss of utility and originality that reduces its value. Consequently, it is important to include deterioration while dealing with inventory models. Generally, the customer used to pay the bill immediately when the order is placed. Though, this is not the situation in real life. Sometimes, the retailers permit some time interval up to which the customer can clear all its accounts owing to credit periods. In a competitive market, trade credit policy is used as a promotional tool that helps to sponsor the goods and lift the sale. This allows the customer to buy the products under less capital investment. Interest is earned by the retailer, if the amount is paid before the stipulated period. This article introduces an EPQ model for perishable products with two-level permissible credit periods under inflation. The manufacturing rate includes reliability factors, assuming demand to be stock sensitive. The classical optimization method is being used to solve the given inventory problem. The purpose of the article is to minimize retailer's total cost function per unit time related to manufacturing time period. A sensitivity analysis is shown, depending on the numerical example with some managerial insights.

The article is formulated as follows: Section 2 introduces literature review. Section 3 includes assumptions and notations that are being used to structure the model. Section 4 formulates the mathematical model. In Section 5, an algorithm is developed to calculate the value of decision variable (t_1) and the required feasible solution. In section 6, the sensitivity analysis table is exposed to signifies the dependence of inventory parameters on optimal solutions. At the end, Section 7 concludes the analysis under future scope.

2. LITERATURE REVIEW

Esmaeili and Nasrabadi (2021) introduced a single-vendor multi retailer inventory model for perishable products under inflation where demand is stock-dependent. Das *et al.* (2021) established a preservation-based inventory model for non-instantaneous perishable products under multiple trade credit financing. In this model instead of a single credit period, the model is formulated for multi-period trade credit policy where the demand rate is the function of stock-level and selling price. Mahato and Mahata (2021) developed a deteriorating inventory model with termination date for two-level trade credit financing. The model investigated some lemmas to calculate total annual profit. Chakraborty *et al.* (2020) worked on a non-instantaneous deteriorating inventory model assuming multi-item and multi-warehouse backlogging with inflation. Ullah *et al.* (2019) established a two-echelon inventory supply model under controllable deterioration rate through preservation investments.

Aliabadi *et al.* (2019) analysed a carbon sensitive demand inventory model with allowable credit periods for deteriorating products. Mohanty *et al.* (2018) studied an inventory system for perishable products under preservation technology and trade credit policy. Kaur *et al.* (2016) considered an EOQ model for time sensitive deterioration rate under allowable delay in payments. Cardenas-Barron *et al.* (2020) developed an EOQ inventory system for stock sensitive demand function, variable holding cost and allowable credit interval. Khanna *et al.* (2020) studied preservation technology to control the rate of deterioration for stock-dependent demand and variable holding cost. Shah and Cardenas-Barron (2015) analysed the decision taken by retailers when the manufacturer offers cash discount and credit periods. Sharma *et al.* (2018) formulated a deteriorating supply chain model having expiration date. Yadav *et al.* (2016) developed a two-storage deteriorating model formulating, genetic algorithm under inflation. Manna *et al.* (2016) introduced an EOQ model for constant deterioration rate and ramp type demand. Sarkar et al. (2014) considered an EMQ model under inflation and reliability. They assumed demand to be the function of stock-level and selling price. Mahapatra *et al.* (2017) studied an inventory system for stock and time sensitive demand function with permissible backorder. Shah and Vaghela (2018) developed an imperfect production model under maximum reliability and inflation rate. Adak and Mahapatra (2018) presented a deteriorating model under reliability and trade credit financing for demand rate dependent on stock-level, price and reliability. The model is formulated under permissible shortages. The objective is to evaluate the expected cost function.

Saxena *et al.* (2016) developed a two-warehouse model for perishable products under reliability. Trade credit policy is being used under the effect of inflation. The model calculated the total cost function for production time. Nagpal and Chanda (2021) discussed a technology product model for two succeeding generations with allowable delay in payment. Shaikh *et al.* (2020) developed an EPQ model under permissible partial credit-period assuming where demand is price-sensitive.

3. NOTATIONS AND ASSUMPTIONS

The model practices following notations and assumptions:

3.1 Notations

C_p	Manufacturing cost per unit (in $)
C_r	Repairable cost per unit (in $)
P	Selling price per unit (in $)
ψ	Inflation rate in percentage
η	Rate of reliability in percentage
δ	Part of payment, paid by the customer while placing the order, $0 \le \delta \le 1$
λ	Manufacturing rate
A	Ordering cost per order (in $)
h	Holding cost per unit (in $)
θ	Deterioration rate, $0 \le \theta < 1$
α	Scale demand, $\alpha > 0$
β	Stock-dependent variable, $\beta > 0, \beta << \alpha$
$R(I(t))$	Demand rate depends on stock level
t_1	Manufacturing time (in years)
T	Cycle time in years
$I(t)$	Inventory level at time t during interval $[0,T]$
I_e	Interest earned thru the vendor (in $/ year)
I_c	Interest charged thru the vendor (in $/year)
M	Credit period given by the trader to the vendor
N	Credit period agreed by the vendor to the customer
TC	Total cost per unit time (in $/year)

3.2 Assumptions

- Manufactured products are repairable and replaceable.
- Lead time is zero i.e., requirement for the products is fulfilled instantaneously.
- Demand function is stock-dependent and is given by $R(I(t)) = \alpha + \beta I(t)$, $\alpha > 0$, $\beta > 0, \beta << \alpha$
- The model considers infinite planning horizon.
- Shortages are not permissible.
- The inflation rate is assumed to be ψ .
- The paper is developed under partial trade credit policy.

4. MATHEMATICAL MODEL

Initially, the stock level is supposed to be zero. At $t = 0$, the company starts manufacturing the products with λ units at a time. The demand rate is the function of stock level and is expressed as $R(I(t))$. Here, the demand rate is lower than the manufacturing rate and hence at time $t = t_1$, the firm decides to stop the production. After time $t = t_1$ the inventory decreases due to the effect of demand and reaches to zero at time $t = T$.

The differential equations for the inventory level at time t during time interval $[0,T]$ is formulated as follows:

$$\frac{dI_1(t)}{dt} + \theta I_1(t) = \eta\lambda - R(I_1(t)) \text{ ,}$$

where $R(I(t)) = \alpha + \beta I(t)$ and thus the equation will be

$$\frac{dI_1(t)}{dt} + \theta I_1(t) = \eta\lambda - (\alpha + \beta I_1(t)),\ t \in [0, t_1] \tag{1}$$

$$\frac{dI_2(t)}{dt} + \theta I_2(t) = -(\alpha + \beta I_2(t)),\ t \in [t_1, T] \tag{2}$$

Using boundary condition $I_1(0) = I_2(T) = 0$, equation (1) and (2) yields:

$$I_1(t) = \frac{(\lambda\eta - \alpha)(1 - e^{-(\beta+\theta)t})}{(\theta + \beta)} \tag{3}$$

$$I_2(t) = \frac{\alpha}{(\theta + \beta)}\left(e^{(\theta+\beta)(T-t)} - 1\right) \tag{4}$$

Using the continuity of inventory function at time $t = t_1$, the cycle time is given by

$$T = t_1 + \frac{(\lambda\eta - \alpha)(1 - e^{-(\beta+\theta)t_1})}{(\theta + \beta)\alpha} \tag{5}$$

The order quantity Q is derived as follows

$$Q = \int_0^{t_1} (\alpha + \beta I_1(t))dt + \int_{t_1}^{T} (\alpha + \beta I_2(t))dt \tag{6}$$

The manufacturing cost is expressed as MC = $\frac{C_p\lambda(1 - e^{-\psi t_1})}{\psi}$

The holding cost for inventory products is calculated as HC = $h\left[\int_0^{t_1} e^{-\psi t} I_1(t)dt + \int_{t_1}^{T} e^{-\psi t} I_2(t)dt\right]$

The repairing cost for imperfect products is provided by RC = $C_r(1-\eta)Q$. The ordering cost is OC = $Ae^{-\psi T}$.

The model deals with two-level partial credit periods i.e., M and N . With these credit periods, two scenarios arise i.e. (1) $M < N$ and (2) $N < M$. Based on the values of M and N, nine viable solutions ascend. In scenario (1) the credit period offered by the trader to the vendor is less than the period offered by the vendor to the customer. For this scenario, we have three cases as discussed below:

Case 1: $0 < M < N < t_1 < T$

In this case the interest charge and the interest earned is calculated as follows:

IC1= $C_p I_c \left(\int_M^{t_1} e^{-\psi t} I_1(t)dt + \int_{t_1}^{T} e^{-\psi t} I_2(t)dt\right)$, IE1 = $PI_e\left(\delta\int_0^M e^{-\psi t}(\alpha + \beta I_1(t))tdt\right)$

Problem: Minimize TC1

The total cost is thus given by

$$\text{TC1}=\frac{1}{T}\left(MC+HC+RC+OC+IC1-IE1\right)$$

$$\text{TC1}=\frac{1}{T}\left(\begin{array}{l}\dfrac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int\limits_0^{t_1}e^{-\psi t}I_1(t)dt+\int\limits_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ +C_pI_c\left(\int_M^{t_1}e^{-\psi t}I_1(t)dt+\int_{t_1}^{T}e^{-\psi t}I_2(t)dt\right)-PI_e\left(\delta\int\limits_0^{M}e^{-\psi t}(\alpha+\beta I_1(t))tdt\right)\end{array}\right) \tag{7}$$

Case 2: $0<t_1<M<N<T$

Here, the interest earned and interest charge is allotted as:

$$\text{IE2}=PI_e\left(\delta\int\limits_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int\limits_{t_1}^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right),\ \text{IC2}=C_pI_c\int\limits_M^{T}e^{-\psi t}I_2(t)dt$$

Problem: Minimize TC2

The total cost in this case is given by:

$$\text{TC2}=\frac{1}{T}\left(\begin{array}{l}\dfrac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int\limits_0^{t_1}e^{-\psi t}I_1(t)dt+\int\limits_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ +C_pI_c\int\limits_M^{T}e^{-\psi t}I_2(t)dt-PI_e\left(\delta\int\limits_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int\limits_{t_1}^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right)\end{array}\right) \tag{8}$$

Case 3: $0<t_1<T<M<N$

In case 3, both the credit periods are greater than the cycle time. Here, all the account is cleared before the end of cycle time and thus the interest charges i.e., $IC3=0$ and the interest earned by the retailer is given by:

$$\text{IE3}=PI_e\left(\delta\int\limits_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int\limits_{t_1}^{T}e^{-\psi t}(\alpha+\beta I_2(t))tdt+\delta T\int\limits_T^{M}e^{-\psi t}Qdt\right)$$

Problem: Minimize TC3

The total cost per unit time is:

$$\text{TC3}=\frac{1}{T}\left(\begin{array}{l}\dfrac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int\limits_0^{t_1}e^{-\psi t}I_1(t)dt+\int\limits_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ -PI_e\left(\delta\int\limits_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int\limits_{t_1}^{T}e^{-\psi t}(\alpha+\beta I_2(t))tdt+\delta T\int\limits_T^{M}e^{-\psi t}Qdt\right)\end{array}\right) \tag{9}$$

Scenario 2 is the case where credit period given by the vendor to the customer is less than the period given by the trader to the vendor. Under this scenario we have six cases as discussed below:

Case 4: $0<N<M<t_1<T$

Here, one can observe that both the credit period lies in between $[0,t_1]$ and thus the charges related to this particular situation with associated cost function is given by

$$\text{IC4}=C_PI_c\left(\int\limits_M^{t_1}e^{-\psi t}I_1(t)dt+\int\limits_{t_1}^{T}e^{-\psi t}I_2(t)dt\right)$$

$$\text{IE4}=PI_e\left(\delta\int\limits_0^{N}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int\limits_N^{M}e^{-\psi t}(\alpha+\beta I_1(t))tdt\right)$$

Problem: Minimize TC4

$$TC4=\frac{1}{T}\begin{pmatrix}\frac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int_0^{t_1}e^{-\psi t}I_1(t)dt+\int_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ +C_PI_c\left(\int_M^{t_1}e^{-\psi t}I_1(t)dt+\int_{t_1}^{T}e^{-\psi t}I_2(t)dt\right)\\ -PI_e\left(\delta\int_0^{N}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int_N^{M}e^{-\psi t}(\alpha+\beta I_1(t))tdt\right)\end{pmatrix} \tag{10}$$

Case 5: $0<N<t_1<M<T$

The credit period offered by the trader to the vendor lies between $[t_1,T]$ and hence the interest earned by the vendor up to time period M is

IE5= $PI_e\left(\delta\int_0^{N}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int_N^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int_{t_1}^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right)$ and the interest charge is

IC5= $C_pI_c\int_M^{T}e^{-\psi t}I_2(t)dt$,

Problem: Minimize TC5

The total cost function with these charges is

$$TC5=\frac{1}{T}\begin{pmatrix}\frac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int_0^{t_1}e^{-\psi t}I_1(t)dt+\int_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ -PI_e\left(\delta\int_0^{N}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int_N^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\int_{t_1}^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right)\\ +C_pI_c\int_M^{T}e^{-\psi t}I_2(t)dt\end{pmatrix} \tag{11}$$

Case 6: $0<t_1<N<M<T$

In this case, the interest earned, interest charge and total profit function are described as shown below:

IC6= $C_PI_C\left(\int_M^{T}e^{-\psi t}I_2(t)dt\right)$

IE6= $PI_e\left(\delta\int_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int_{t_1}^{N}e^{-\psi t}(\alpha+\beta I_2(t))tdt+\int_N^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right)$

Problem: Minimize TC6

$$TC6=\frac{1}{T}\begin{pmatrix}\frac{C_p\lambda(1-e^{-\psi t_1})}{\psi}+h\left[\int_0^{t_1}e^{-\psi t}I_1(t)dt+\int_{t_1}^{T}e^{-\psi t}I_2(t)dt\right]+C_r(1-\eta)Q+Ae^{-\psi T}\\ -PI_e\left(\delta\int_0^{t_1}e^{-\psi t}(\alpha+\beta I_1(t))tdt+\delta\int_{t_1}^{N}e^{-\psi t}(\alpha+\beta I_2(t))tdt+\int_N^{M}e^{-\psi t}(\alpha+\beta I_2(t))tdt\right)\\ +C_PI_C\left(\int_M^{T}e^{-\psi t}I_2(t)dt\right)\end{pmatrix} \tag{12}$$

Case 7: $0<N<t_1<T<M$

Here, no interest is paid i.e., $IC7=0$, the interest earned and total cost function per unit time are formulated as:

IE7= $PI_e \left(\begin{array}{l} \delta \int_0^N e^{-\psi t}(\alpha+\beta I_1(t))tdt + \int_N^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \int_{t_1}^{T} e^{-\psi t}(\alpha+\beta I_2(t))tdt \\ +T\int_T^M e^{-\psi t} Qdt \end{array} \right)$

Problem: Minimize TC7

$$TC7 = \frac{1}{T}\left(\begin{array}{l} \frac{C_p\lambda(1-e^{-\psi t_1})}{\psi} + h\left[\int_0^{t_1} e^{-\psi t} I_1(t)dt + \int_{t_1}^{T} e^{-\psi t} I_2(t)dt\right] + C_r(1-\eta)Q + Ae^{-\psi T} \\ -PI_e\left(\begin{array}{l} \delta \int_0^N e^{-\psi t}(\alpha+\beta I_1(t))tdt + \int_N^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \int_{t_1}^{T} e^{-\psi t}(\alpha+\beta I_2(t))tdt \\ +T\int_T^M e^{-\psi t} Qdt \end{array} \right) \end{array} \right) \tag{13}$$

Case 8: $0 < t_1 < N < T < M$

In case 8, the interest charges are zero given by $\text{IC8} = 0$ and the interest earned is calculated by

IE8= $PI_e\left(\delta\int_0^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \delta\int_{t_1}^{N} e^{-\psi t}(\alpha+\beta I_2(t))tdt + \int_N^T e^{-\psi t}(\alpha+\beta I_2(t))tdt + T\int_T^M e^{-\psi t}Qdt \right)$

The objective function with respect to the above interest earned function is
Problem: Minimize TC8

$$TC8 = \frac{1}{T}\left(\begin{array}{l} \frac{C_p\lambda(1-e^{-\psi t_1})}{\psi} + h\left[\int_0^{t_1} e^{-\psi t} I_1(t)dt + \int_{t_1}^{T} e^{-\psi t} I_2(t)dt\right] + C_r(1-\eta)Q + Ae^{-\psi T} \\ -PI_e\left(\begin{array}{l} \delta \int_0^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \delta\int_{t_1}^{N} e^{-\psi t}(\alpha+\beta I_2(t))tdt + \int_{N}^{T} e^{-\psi t}(\alpha+\beta I_2(t))tdt \\ +T\int_T^M e^{-\psi t} Qdt \end{array} \right) \end{array} \right) \tag{14}$$

Case 9: $0 < t_1 < T < N < M$

Here, the interest paid, interest earned and total cost function is formulated as:

$\text{IC9} = 0$

IE9= $PI_e\left(\delta\int_0^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \delta\int_{t_1}^{T} e^{-\psi t}(\alpha+\beta I_2(t))tdt + \delta T\int_T^N e^{-\psi t}Qdt + T\int_N^M e^{-\psi t}Qdt \right)$

Problem: Minimize TC9

$$TC9 = \frac{1}{T}\left(\begin{array}{l} \frac{C_p\lambda(1-e^{-\psi t_1})}{\psi} + h\left[\int_0^{t_1} e^{-\psi t} I_1(t)dt + \int_{t_1}^{T} e^{-\psi t} I_2(t)dt\right] + C_r(1-\eta)Q + Ae^{-\psi T} \\ -PI_e\left(\begin{array}{l} \delta \int_0^{t_1} e^{-\psi t}(\alpha+\beta I_1(t))tdt + \delta\int_{t_1}^{T} e^{-\psi t}(\alpha+\beta I_2(t))tdt + \delta T\int_{T}^{N} e^{-\psi t}Qdt \\ +T\int_N^M e^{-\psi t} Qdt \end{array} \right) \end{array} \right) \tag{15}$$

The objective function TC is continuous function of manufacturing time t_1.

5. COMPUTATIONAL ALGORITHM

The article uses optimization method to solve the given EOQ problem. The purpose of the model is to minimize the total cost function per unit time. The solution method is defined as follows:

Step 1. Allocate numerical values to the inventory variables.

Step 2. Calculate derivative of objective function i.e., total cost function per unit time with respect to manufacturing time t_1 as shown below:

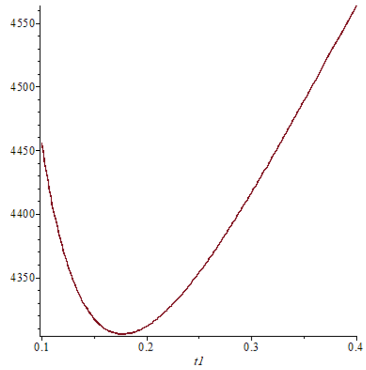
$$\frac{\partial TC}{\partial t_1} = 0 \tag{16}$$

from equation (16), value of t_1 is obtained and is used to calculate the cost function.

Step 3. Convexity of the total cost function is confirmed through graph.

6. NUMERICAL EXAMPLE AND SENSITIVITY ANALYSIS

Here, we formulate an example by using numerical values of inventory parameters.



Example 1: Consider $\alpha = 60$, $\beta = 3$, $h = 5$, $\lambda = 130$, $\theta = 0.3$, $A = 200$, $C_p = 50$, $C_r = 35$, $\psi = 0.06$, $\eta = 0.95$, $\delta = 0.05$, $I_e = 0.10$, $I_c = 0.15$, $P = 178$, $M = 0.30$, $N = 0.28$.

With the help of computational algorithm, under derivative of total cost function with respect to manufacturing time t_1 yields $t_1 = 0.178$ year, $T = 0.319$ year, $TC = 4507.39$ \$/year. Figure 1. Represents the convex nature of total cost function.

Figure1. Convexity of total cost function with respect to manufacturing time

Table 1. The feasible solution of the inventory problem

Cases	***M***	***N***	**Manufacturing time (t_1)**	**Cycle time (T)**	**Total cost per unit time (TC)**
Case1. $0 < M < N < t_1 < T$	0.34	0.35	0.360	0.447	5815.822
Case2. $0 < t_1 < M < N < T$	0.30	0.40	0.204	0.437	3865.460
Case3. $0 < t_1 < T < M < N$	0.30	0.35	0.194	0.285	5501.202
Case4. $0 < N < M < t_1 < T$	0.10	0.05	0.363	0.451	5821.227
Case5. $0 < N < t_1 < M < T$	0.34	0.28	0.308	0.387	5728.037
Case6. $0 < t_1 < N < M < T$	0.30	0.28	0.178	0.320	4507.396
Case7. $0 < N < t_1 < T < M$	0.36	0.22	0.252	0.321	5637.414
Case8. $0 < t_1 < N < T < M$	0.30	0.24	0.190	0.296	5016.384
Case9. $0 < t_1 < T < N < M$	0.60	0.50	0.162	0.211	5508.122

A sensitivity analysis is performed for case3 by changing the inventory parameters upto 10% and 20%.

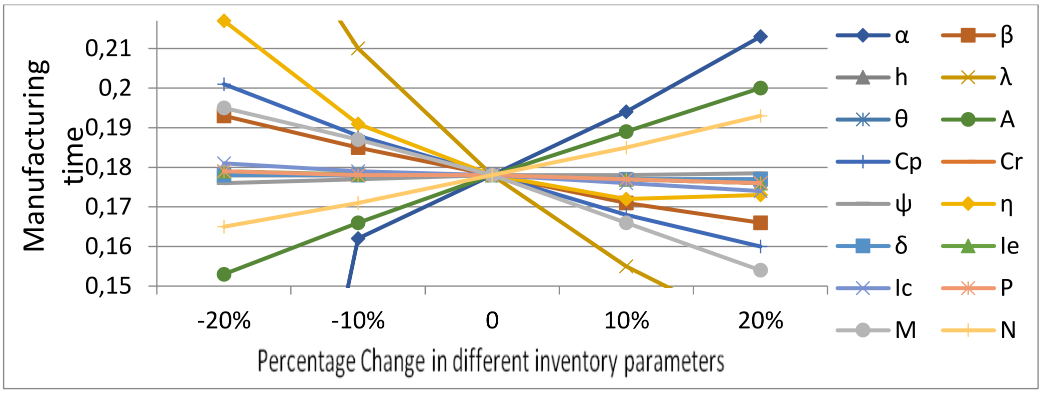


Figure 2. Effect of different parameters on manufacturing time

- With an increase in α , the manufacturing time increases. The change is not permissible as due to the high demand; the company will produce more products to satisfy the consumption rate that results in increasing the total cost function. Deterioration rate given by θ ,decreases the value of t_1. The company should stop manufacturing products if the deterioration rate increases with time. Production time is less sensitive related to cost functions i.e., holding cost, purchase cost. Also, when manufacturing rate increases, the production time decreases. The parameter t_1 decreases with an increase in interest charges and interest earned.

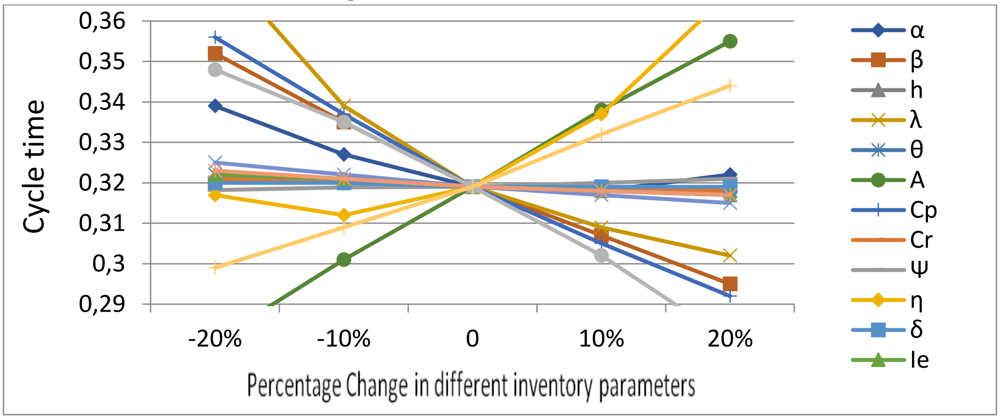


Figure 3. Effect of different parameters on cycle time

- With an increase in credit period M , cycle time and total cost function decreases significantly. This reveals that more will be the credit period offered by the trader to the vendor, less will be the total cost function. So, the change is permissible. Furthermore, cycle time is insensitive with respect to δ .

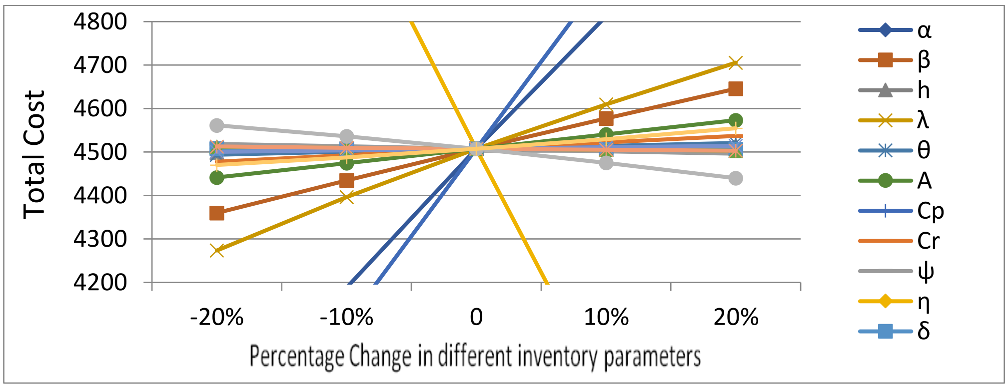


Figure 4. Effect of different parameters on total cost

When stock-dependent parameter (β) increases, the total cost function and cycle time reduces. This reveals that as β increases, the company should control the manufacturing rate to evade the total cost function that increases due to high demand. When deterioration increases, the organization must focus on the spoilage rate to reduce the economic loss. Total cost increases with an increase in h, C_p, C_r, A .

7. CONCLUSION

The article formulated an EPQ model with reliability and inflation for perishable products under two-level credit financing. The demand rate is the function of stock level to reflect the real-life situation. The approach aimed at minimizing the total cost function related to the decision variable. To calculate the decision variable i.e., production time, the model uses classical optimization methods. If the demand is stock sensitive, one must reduce the length of cycle time to minimize the cost function. In the inventory system, deterioration is an unavoidable phenomenon. With higher rates of deterioration companies should stop manufacturing products to avoid financial loss. Moreover, the production time is insensitive for holding cost and repairable cost. Also, the production time decreases when manufacturing rate increases.
The work can further be extended by introducing advertisement and discount policy. The deterioration can be considered as a time dependent function having an expiration date. Instead of dealing with stock-dependent demand rate one can assume price-dependent or time-dependent demand rate.
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