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An Inventory Model of Deteriorating Items under Inflation and Discount Rate with Power Demand and Time Dependent Holding Cost

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ABSTRACT: In this research paper, our objective is to investigate the inventory system for perishable items with power demand pattern where two parameter Weibull distribution and Pareto Type-I distribution for deteriorating rate of deteriorating items with varying holding cost are considered. To make it more suitable to the present environment, the effect of inflation is also considered. The influences of inflation and time value of money on the inventory system are investigated with the help of numerical example.

KEYWORDS: Inventory System, Power Demand, Weibull distribution, Pareto distribution, Deterioration.

I. INTRODUCTION

In our daily life, we are using so many items that get decayed, damaged, evaporated, expired, invalid, devaluated and so on through time. According to the definition of deteriorating items, they can be classified into two categories. Items like meat, vegetables, fruits, medicines, flowers, films and so on which are having a short natural life cycle and decayed, damaged, evaporative, or expired through time, are referred in the first category. After a span of popularity in the market, due to the demand or choice of the consumers or up gradation in technology, some products like computer chips, mobile phones, fashion, seasonal goods and so on lose part of or total value through time. Such type of items having a short market life cycle referred in the second category.

Deteriorating inventory has been widely studied in recent years.Ghare and Schrader [6] were two of the earliest researchers to consider continuously decaying inventory for a constant demand.Ajanta Roy [1] presented an inventory model for time proportional deterioration rate and demand as a function of selling price. The Author discussed the model with and without shortage in which the shortages were completely backlogged.Sanjay Jain and Mukesh Kumar [9] explained an inventory model with ramp type demand and three parameter Weibull deterioration rate. The Authors also analysed and summarized economic order quantity models developed by few researchers. There are some products which start deteriorating only after some interval of time. This was explained by taking three parameters Weibull distribution deterioration rate.

Aggarwal and Bahari-Hasani [2] studied a model assuming that items are deteriorating at a constant rate, in which, the production rate is known but can vary from one period to another period over a finite planning period.Kirtan Parmar and U. B. Gothi[7] developed a deterministic inventory model for deteriorating items with time to deterioration having Exponential distribution and with time-dependent quadratic demand. In this model, shortages are not allowed and holding cost is time-dependent.

Anil Kumar Sharma, Manoj Kumar Sharma and Nisha Ramani [3] described an inventory model for two – parameter Weibull distribution deterioration rate and demand rate is of power pattern. Manoj Kumar Meher, Gobinda Chandra Panda, Sudhir Kumar Sahu [8] adopted a two – parameter Weibull distribution deterioration to develop an inventory model under permissible delay in payments.

R.Amutha and E.Chandrasekaran [4] developed an inventory model for deteriorating items with three-parameter Weibull deterioration and price dependent demand.Kirtan Parmar and U. B. Gothi [10] developed an economic production model for deteriorating items using three parameter Weibull distribution with constant production rate and time varying holding cost.Devyani Chatterji and U. B. Gothi [5] analysed an inventory model for deteriorating items with constant holding cost. Two and three parameter Weibull distributions were assumed for time to deterioration of items for two different time intervals. Shortages are allowed to occur and they were partially backlogged.

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An Inventory model for deteriorating items having two components mixture of Pareto lifetime and selling price dependent demand was formulated by Vijayalakshmi. G, Srinivasa Rao. K and Nirupama Devi [13].U.B. Gothi and Ankit Bhojak [12] have developed production inventory model, in which they considered the time to ameliorate following two parameter Weibull distribution and demand as an exponential function of time. In their work, shortages were allowed to occur and dissatisfied demand was fully backlogged.

Srichandan Mishra, L.K. Raju, U.K. Misra and G.Misra [10] have developed an EOQ model for perishable items with power demand pattern by using two parameter Weibull distributionfor deterioration.Here the deterioration starts after a fixed interval of time and shortages were partially backlogged.

In this paper, we have redeveloped the above inventory model by considering different deterioration rates for different time Intervals. The Inventory level gradually decreases due to combined effect of deterioration and demand.In this model shortages are allowed to occur and dissatisfied demands are partially backlogged. Inventory Holding Cost is time dependent and linear function of time. In this model we have used two parameter Weibull distribution and Pareto type-I distribution for deterioration rates in the time intervals [0, μ] and [μ, t_1] respectively.Numerical example and sensitivity analysis are also carried out by changing the values of all the parameters one by one.

The distribution of the time to deteriorate is random variable following two parameter Pareto type – I distribution (during period $[\mu, t_1]$) and its probability density function is $f(t) = \frac{\theta}{\mu}\left(\frac{t}{\mu}\right)^{-\theta-1}$; $t \geq \mu$, where θ and μ are parameters taking positive real values. The instantaneous rate of deterioration $\theta(t)$of the non-deteriorated inventory at time t, can be obtained from$(t) = \frac{f(t)}{1-F(t)}$, where $F(t) = 1 - \left(\frac{t}{\mu}\right)^{-\theta}$ is the cumulative distribution function for the two parameter Pareto type – I distribution. Thus, the instantaneous rate of deterioration of the on-hand inventory is$(t) = \frac{\theta}{t}$.

II. ASSUMPTIONS

The following assumptions are considered to develop this model

1. The inventory system involves only one item and one stocking point.
2. Replenishmentrate is infinite but size is finite.
3. Time horizon is finite.
4. Lead-time is zero.
5. The model is studied when shortages are allowed and partially backlogged.
6. The deteriorated items are not replaced during the given cycle.
7. Deterioration occurs when the item is effectively in stock.
8. The time-value of money and inflation are considered.
9. Holding cost C_h = a+bt (a, b > 0) is a linear function of time.
10. For the model, the deterioration rate

$$\theta(t) = \begin{cases} \alpha\beta t^{\beta-1} & ; 0 \leq t \leq \mu \\ \dfrac{\theta}{t} & ; \mu \leq t \leq t_1 \end{cases}$$

where α is a scale parameter (0 < α << 1) and β is a shape parameter (β > 0).

11. Purchasing cost, Deterioration cost, Shortage cost, Opportunity cost and ordering cost are known and constants.
12. The second and higher powers of α and δ are neglected in this analysis of the model hereafter.

III. NOTATIONS

The following notations are used to develop the mathematical model:

1. $Q(t)$ =On hand inventory level at time t, $t \geq 0$.
2. $R(t)$ =Demand Rate varying over time.
3. $\theta(t)$ =Deterioration rate.
4. V = Inventory at time $t = 0$.
5. A = Ordering cost per order during the cycle period.
6. T = Duration of a cycle.
7. i = The inflation rate per unit time.
8. r = The discount rate representing the time value of money.

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9. δ = Backlogging parameter.(0<δ<<1)
10. C_p =The purchasing cost per unit item.
11. C_d =The deterioration cost per unit.
12. C_s =The shortage cost per unit.
13. C_l =The opportunity cost per unit time.
14. C_h =The holding cost per unit per unit time.
15. TC = Total Cost per unit time.

IV. MATHEMATICAL FORMULATIONAND SOLUTION

The objective of the inventory problem is to determine the optimal order quantity and the length of ordering cycle so as to keep the total relevant cost as low as possible. During the period [0, μ] and $[\mu, t_1]$ the inventory level is decreasing due to combined effect of deterioration and demand.

At time t_1 the inventory reaches at zero level. Thereafter, shortages are allowed to occur during the time interval [t_1,T]. Some shortages are backlogged and part of it is lost. The behaviour of inventory during the period [0, T] is depicted in the following inventory-time diagram.

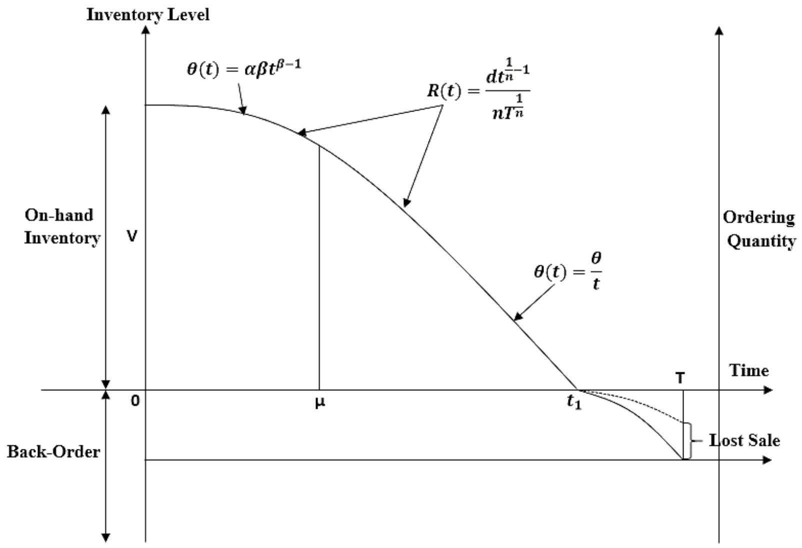

Figure-1 Graphical Presentation of the Inventory System

Differential equations pertaining to the situations as explained above are given by

$$\frac{dQ(t)}{dt} + \alpha\beta t^{\beta-1}Q(t) = -\frac{dt^{\frac{1}{n}-1}}{nT^{\frac{1}{n}}} \qquad 0 \le t \le \mu \qquad (1)$$

$$\frac{dQ(t)}{dt} + \frac{\theta}{t}Q(t) = -\frac{dt^{\frac{1}{n}-1}}{nT^{\frac{1}{n}}} \qquad \mu \le t \le t_1 \qquad (2)$$

$$\frac{dQ(t)}{dt} = -\frac{dt^{\frac{1}{n}-1}}{nT^{\frac{1}{n}}}e^{-\delta(T-t)} \qquad t_1 \le t \le T \qquad (3)$$

Using boundary conditions

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$$Q(0) = V, Q(\mu) = 0 \text{ and } Q(t_1) = 0$$

the solutions of the differential equations (1), (2), and (3) are

$$Q(t) = \left(1 - \alpha t^{\beta}\right)V - \frac{d}{T^{\frac{1}{n}}}\left(t^{\frac{1}{n}} + \frac{\alpha}{n\beta + 1}t^{n\beta+1}\right) + \frac{\alpha d}{T^{\frac{1}{n}}}t^{\beta+\frac{1}{n}} \tag{4}$$

$$Q(t) = \frac{d}{T^{\frac{1}{n}}(n\theta + 1)}\left[t_1^{\frac{1}{n}+\theta} \cdot t^{-\theta} - t^{\frac{1}{n}}\right] \tag{5}$$

$$Q(t) = \frac{d}{T^{\frac{1}{n}}}\left[(1 - \delta T)\left(t_1^{\frac{1}{n}} - t^{\frac{1}{n}}\right) + \frac{\delta}{n+1}\left(t_1^{\frac{1}{n}+1} - t^{\frac{1}{n}+1}\right)\right] \tag{6}$$

V. COSTS COMPONENTS

Under the consideration of inflation and time value of money, the total cost function consists of the following components.

1) Ordering Cost

Over the period [0, T], theordering cost (OC) is

$$OC = A \tag{7}$$

2) Deterioration Cost

Over the period $[0, t_1]$, the deterioration cost (DC) is

$$\text{DC} = C_d\left(\int_0^{\mu} \alpha\beta t^{\beta-1}\text{Q(t)}e^{-(\text{r-i})t}\text{dt} + \int_{\mu}^{t_1}\frac{\theta}{t}\text{Q(t)}e^{-(\text{r-i})t}\text{dt}\right)$$

$$\text{DC} = \frac{C_d\theta\text{d}}{T^{\frac{1}{n}}(\text{n}\theta+1)}\left(-\frac{t_1^{\frac{1}{n}+\theta}\left(t_1^{-\theta} - \mu^{-\theta}\right)}{\theta} - \left(t_1^{\frac{1}{n}} - \mu^{\frac{1}{n}}\right)\text{n} - (\text{r} - \text{i})\left(\frac{t_1^{\frac{1}{n}+\theta}\left(t_1^{1-\theta} - \mu^{1-\theta}\right)}{1-\theta} - \left(\frac{t_1^{\frac{1}{n}+1} - \mu^{\frac{1}{n}+1}}{\frac{1}{n}+1}\right)\right)\right) \tag{8}$$

3) Lost Sale Cost

The lost sale cost (LSC) over the period $[t_1, T]$is

$$LSC = C_l\int_{t_1}^{T}\frac{dt^{\frac{1}{n}-1}}{nT^{\frac{1}{n}}}\left[1 - \frac{1}{1 + \delta(T - t)}\right]e^{-(r-i)t}dt$$

$$LSC = \frac{C_l d\delta}{nT^{\frac{1}{n}}}\left[\begin{matrix} T\left(\dfrac{T^{\frac{1}{n}} - t_1^{\frac{1}{n}}}{\frac{1}{n}}\right) - \left(\dfrac{T^{\frac{1}{n}+1} - t_1^{\frac{1}{n}+1}}{\frac{1}{n}+1}\right) + \\ (i - r)\left(\left(\dfrac{T^{\frac{1}{n}+1} - t_1^{\frac{1}{n}+1}}{\frac{1}{n}+1}\right) - \left(\dfrac{T^{\frac{1}{n}+2} - t_1^{\frac{1}{n}+2}}{\frac{1}{n}+2}\right)\right)\end{matrix}\right] \tag{9}$$

4)Inventory Holding Cost

The inventory holding cost (IHC) for carrying inventory over the period $[0, t_1]$

$$IHC = \int_0^{t_1} Q(t)(a + bt)e^{-(r-i)t}\,dt$$

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$$IHC=\left[\begin{array}{c} a\left(\frac{d\left(\frac{t_1^{\frac{1}{n}+\theta}\mu^{-\theta}}{n\theta+1}+\frac{n\theta\mu^{\frac{1}{n}}}{n\theta+1}+\frac{n\alpha\beta\mu^{\frac{1}{n}+\beta}}{\beta n+1}\right)\left(\mu-\frac{\alpha\mu^{\beta+1}}{\beta+1}\right)}{(1-\alpha\mu^{\beta})T^{\frac{1}{n}}}-\frac{d\left(\frac{\mu^{\frac{1}{n}+1}}{\frac{1}{n}+1}+\frac{\alpha\mu^{\frac{1}{n}+\beta+1}}{(\beta n+1)\left(\frac{1}{n}+\beta+1\right)}\right)}{T^{\frac{1}{n}}}+\frac{\alpha d\mu^{\frac{1}{n}+\beta+1}}{T^{\frac{1}{n}}\left(\frac{1}{n}+\beta+1\right)}\right) \\ +(b-a(r-i))\left(\frac{d\left(\frac{t_1^{\frac{1}{n}+\theta}\mu^{-\theta}}{n\theta+1}+\frac{n\theta\mu^{\frac{1}{n}}}{n\theta+1}+\frac{n\alpha\beta\mu^{\frac{1}{n}+\beta}}{\beta n+1}\right)\left(\frac{1}{2}\mu^{2}-\frac{\alpha\mu^{\beta+2}}{\beta+2}\right)}{(1-\alpha\mu^{\beta})T^{\frac{1}{n}}}-\frac{d\left(\frac{\mu^{\frac{1}{n}+2}}{\frac{1}{n}+2}+\frac{\alpha\mu^{\frac{1}{n}+\beta+2}}{(\beta n+1)\left(\frac{1}{n}+\beta+2\right)}\right)}{T^{\frac{1}{n}}}+\frac{\alpha d\mu^{\frac{1}{n}+\beta+2}}{T^{\frac{1}{n}}\left(\frac{1}{n}+\beta+2\right)}\right)- \\ b(r-i)\left(\frac{d\left(\frac{t_1^{\frac{1}{n}+\theta}\mu^{-\theta}}{n\theta+1}+\frac{n\theta\mu^{\frac{1}{n}}}{n\theta+1}+\frac{n\alpha\beta\mu^{\frac{1}{n}+\beta}}{\beta n+1}\right)\left(\frac{1}{2}\mu^{3}-\frac{\alpha\mu^{\beta+3}}{\beta+3}\right)}{(1-\alpha\mu^{\beta})T^{\frac{1}{n}}}-\frac{d\left(\frac{\mu^{\frac{1}{n}+3}}{\frac{1}{n}+3}+\frac{\alpha\mu^{\frac{1}{n}+\beta+3}}{(\beta n+1)\left(\frac{1}{n}+\beta+3\right)}\right)}{T^{\frac{1}{n}}}+\frac{\alpha d\mu^{\frac{1}{n}+\beta+3}}{T^{\frac{1}{n}}\left(\frac{1}{n}+\beta+3\right)}\right)+ \\ \frac{d}{T^{\frac{1}{n}}(n\theta+1)}\left(a\left(\frac{t_1^{\frac{1}{n}+\theta}\left(t_1^{1-\theta}-\mu^{1-\theta}\right)}{1-\theta}-\right)\right) \end{array}\right]$$

(10)

5) Shortage Cost

The shortage cost (SC) over the period $[t_1, T]$ is

$$SC=C_s\int_{t_1}^{T}-Q(t)e^{-(r-i)t}\,dt$$

$$=-\frac{C_s d}{T^{\frac{1}{n}}}\left[\begin{array}{c}\left[\begin{array}{c}\left((1-\delta T)t_1^{\frac{1}{n}}+\frac{\delta}{n+1}t_1^{\frac{1}{n}+1}\right)(T-t_1)-(1-\delta T)\left(\frac{T^{\frac{1}{n}+1}-t_1^{\frac{1}{n}+1}}{\frac{1}{n}+1}\right) \\ -\frac{\delta}{n+1}\left(\frac{T^{\frac{1}{n}+2}-t_1^{\frac{1}{n}+2}}{\frac{1}{n}+2}\right)\end{array}\right] \\ -(r-i)\left((1-\delta T)t_1^{\frac{1}{n}}+\frac{\delta}{n+1}t_1^{\frac{1}{n}+1}\right)\left(\frac{T^2-t_1^2}{2}\right)-(1-\delta T)\left(\frac{T^{\frac{1}{n}+2}-t_1^{\frac{1}{n}+2}}{\frac{1}{n}+2}\right)-\frac{\delta}{n+1}\left(\frac{T^{\frac{1}{n}+3}-t_1^{\frac{1}{n}+3}}{\frac{1}{n}+3}\right)\end{array}\right]$$

(11)

Hence, the total average cost during the time period [0, T] is given by

$$TC=\frac{1}{T}[OC+DC+LSC+IHC+SC] \qquad (12)$$

Our objective is to determine optimum values t_1^* and T^* of t_1 and T respectively so that TC is minimum. Thevalues t_1^* and T^*, for which the TC isminimum, are the solutions of equations $\frac{\partial TC(t_1,T)}{\partial t_1}=0$ and $\frac{\partial TC(t_1,T)}{\partial T}=0$ satisfying the conditions

$$\left(\frac{\partial^2 TC(t_1,T)}{\partial t_1^2}\right)>0 \text{ and } \left(\frac{\partial^2 TC(t_1,T)}{\partial t_1^2}\right)\left(\frac{\partial^2 TC(t_1,T)}{\partial T^2}\right)-\left(\frac{\partial^2 TC(t_1,T)}{\partial t_1\,\partial T}\right)^2>0$$

The optimal Solution of the equation (12) can be obtained by using appropriate software.

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VI. NUMERICAL EXAMPLE

Let us consider the following example to illustrate the above-developed model, taking $A = 500, a = 3, b = 5,$ $C_p = 5, C_d = 7, C_s = 10, r = 0.001, i = 0.0003, \alpha = 0.0001, \beta = 4, n = 2, \mu = 4.1, \delta = 0.0002, d = 60,$ $\theta = 1.2, C_l = 5$.(With appropriate Units)
The optimal values$T^* = 18.15481789 units$, $t_1^* = 5.454210707 units$ and the optimal average total cost

$$TC = 192.6482723 units.$$

VII. SENSITIVITY ANALYSIS

To know, how the optimal solution is affected by the parameters, we derive the sensitivity analysis. Here, we study the sensitivity of total cost TC per time unitwith respect to the changes in the values of the parameters $a, b, C_p, C_d, C_s, r, i, \alpha, \beta, n, \mu, \delta, d, \theta$ and C_l.
The sensitivity analysis is performed by considering 10% and 20% increase and decrease in each one of the above parameters keeping all other remaining parameters as fixed. The last column of theTable – 1 shows the % changes in TC as compared to the original solution corresponding to the change in parameters values, taken as one by one.

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Table-1 Partial Sensitivity Analysis

Parameter	%Change	T	t_1	Q	TC	%change in TC	%change in Q
A	-20	17.68776	5.44872	62.57249	190.39153	-1.22793	0.05171
	-10	17.92802	5.45039	62.55619	191.58658	-0.60795	0.02566
	10	18.40859	5.45360	62.52435	193.90791	0.59632	-0.02526
	20	18.64892	5.45514	62.58133	195.22928	1.28182	0.06586
b	-20	17.71858	5.69707	62.93721	185.63782	-3.69407	0.63490
	-10	17.93050	5.56475	62.93721	189.49396	-1.69357	0.63490
	10	18.42622	5.35465	62.39333	195.94105	1.65108	-0.23475
	20	18.70015	5.26959	62.27005	198.91763	3.19528	-0.43188
C_p	-20	17.18070	5.31830	62.43826	189.22146	-1.83494	-0.16291
	-10	17.67008	5.38512	62.48806	191.01395	-0.90502	-0.08329
	10	18.67546	5.51902	62.59441	194.45681	0.88108	0.08678
	20	19.19173	5.58614	62.65076	196.11071	1.73909	0.17688
C_d	-20	18.20825	5.46657	62.55700	192.66974	-0.04603	0.02694
	-10	18.18820	5.45926	62.54852	192.71425	-0.02293	0.01339
	10	18.14853	5.44483	62.53187	192.80236	0.02278	-0.01323
	20	18.12891	5.43769	62.52370	192.84597	0.04540	-0.02630
C_s	-20	23.02559	5.63758	62.46699	170.01912	-11.79680	-0.11697
	-10	20.23842	5.53357	62.50325	181.95009	-5.60721	-0.05900
	10	16.57205	5.38602	62.57627	202.59921	5.10523	0.05777
	20	15.30523	5.33133	62.57249	190.39153	-1.22793	0.05171
r	-20	18.04017	5.43713	62.52962	193.06370	0.15836	-0.01683
	-10	18.10363	5.44451	62.53482	192.91147	0.07938	-0.00851
	10	18.23422	5.45966	62.54560	192.60464	-0.07980	0.00872
	20	18.30144	5.46745	62.55118	192.45000	-0.16002	0.01765
i	-20	18.20769	5.45659	62.54340	192.66626	-0.04783	0.00521
	-10	18.18794	5.45430	62.54177	192.71240	-0.02390	0.00259
	10	18.14876	5.44975	62.53854	192.80445	0.02386	-0.00257
	20	18.12935	5.44750	62.57249	190.39153	-1.22793	0.05171
α	-20	17.72126	5.39517	62.14310	191.63802	-0.58127	-0.63487
	-10	17.94442	5.42365	62.34170	192.20155	-0.28891	-0.31731
	10	18.39289	5.48028	62.73845	193.30892	0.28557	0.31708
	20	18.61823	5.50844	62.93663	193.85310	0.56788	0.63397
β	-20	16.65216	5.25618	61.18572	188.80933	-2.04875	-2.16569
	-10	17.19611	5.32760	61.67686	190.27270	-1.28957	-1.38037
	10	19.92346	5.66722	64.05647	196.86728	2.13159	2.42456
	20	23.16850	6.03782	66.73200	203.40396	5.52271	6.70267
n	-20	17.31003	5.33086	62.21676	207.33489	7.56202	-0.51708
	-10	17.69563	5.38564	62.38470	199.87515	3.69203	-0.24856

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Parameter	%Change	T	t_1	Q	TC	%change in TC	%change in Q
	10	18.69777	5.52541	62.68408	186.05264	-3.47887	0.23015
	20	19.26677	5.60318	62.81771	179.77101	-6.73768	0.44381
μ	-20	15.85560	4.80829	62.25771	194.11825	0.70544	-0.45160
	-10	16.76182	5.10126	62.21584	192.68404	-0.03860	-0.51856
	10	20.23517	5.87583	63.19494	194.44398	0.87442	1.04701
	20	23.20116	6.39074	64.16860	197.77870	2.60442	2.60385
δ	-20	18.14797	5.45009	62.54661	190.39153	-1.22793	0.01034
	-10	18.15812	5.45105	62.54338	192.77685	0.00954	0.00517
	10	18.17851	5.45299	62.53690	192.74005	-0.00955	-0.00518
	20	18.18875	5.45396	62.53366	192.72161	-0.01912	-0.01037
d	-20	20.33273	5.74598	50.24109	159.41081	-17.30022	-19.66586
	-10	19.10894	5.58172	56.38557	176.16619	-8.60780	-9.84101
	10	17.42366	5.34706	68.70257	209.22398	8.54205	9.85354
	20	16.82010	5.26041	74.87119	225.58910	17.03201	19.71700
θ	-20	18.89171	5.68245	62.55490	191.83220	-0.48053	0.02359
	-10	18.50617	5.55943	62.55100	192.32191	-0.22647	0.01736
	10	17.87106	5.35780	62.52483	193.14912	0.20267	-0.02449
	20	17.60846	5.27475	62.50678	193.50012	0.38476	-0.05335
c_l	-20	18.16867	5.45204	62.54014	192.75635	-0.00109	-0.00001
	-10	18.16848	5.45203	62.54014	192.75740	-0.00055	0.00000
	10	18.16810	5.45201	62.54015	192.75951	0.00055	0.00000
	20	18.16791	5.45200	62.54015	192.76057	0.00110	0.00001

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VIII. GRAPHICAL PRESENTATION

Graphical presentation of the above sensitivity analysis is shown in Figure-2 and Figure-3.

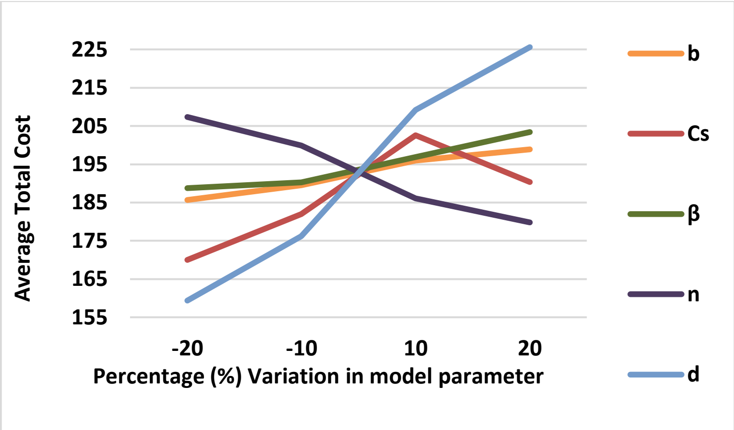

Figure-2 Graphical Presentation

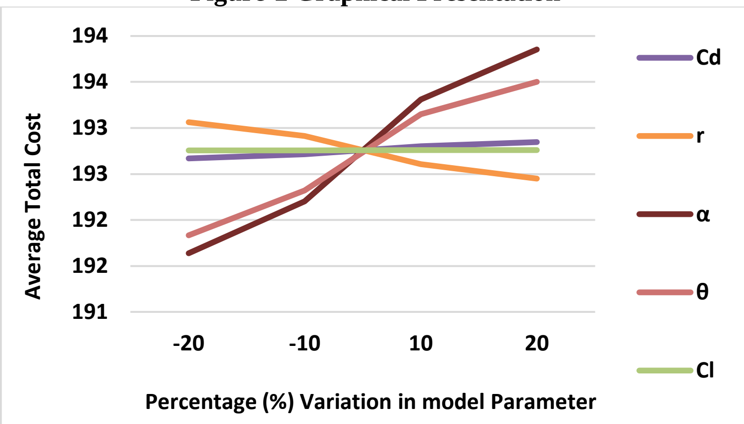

Figure-3 Graphical Presentation

IX. CONCLUSION

From partial Sensitivity Analysis, it is observed that as the values of the parameter $a, b, C_p, C_s, \alpha, \beta, d, \theta$ and C_l increase, the average total cost also increases and with the increase in the values of the parameter r and n, the average total cost decreases.

From Figure-2 it is observed that the total cost per time unit is highly sensitive to changes in the values of b, shape parameter β, shortage cost C_s,n and d.

From Figure-3 it is observed that there is a mild change in the total cost due to the change in the deterioration cost C_d, discount rate r, scale parameter α, opportunity cost C_l and θ.

Hence this model becomes more practicable and very useful in the business organizations dealing with domestic goods, perishable products and other products.

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