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A Novel Approach for Production Planning for Deteriorating Items with Logarithmic Demand

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Abstract— In this study model has been framed to study material cost contributes 50 percent production cost of an organization (i.e Industry). Hence effective inventory control can substantially contribute in a firm's profit. The objective of this research is to develop and production inventory model for deteriorating items with logarithmic demand and a unique optimal cycle time exists to minimize the annual total relevant cost. A suitable mathematical model is developed and the optimal production lot size which minimizes the total cost is derived. The optimal solution is derived and an illustrative example is provided and numerically verified. The validation of result in this model was coded in C and C++.

Keywords— *Operation Management, Inventory Cost, Deteriorating, Cycle time, Break time, Ordering cost, and Holding cost.*

I. INTRODUCTION

The traditional inventory model considers the idea case in which depletion of inventory is caused by a constant demand rate. In formulating inventory models, two factors of the problem have been of growing interest to the researchers, one being the deterioration of items and the other being variation in the demand rate with time. With the advent of Industrialization, production, planning and its control has become one of the most important strategic decision of an organization on inventory model. Moreover the cost of material handling plays a significant role in increasing the overall cost of production. To achieve the targets of production at minimum cost a balance between demand and supply of material inventory is created for optimum utilization of resources. Yong et al. (2010,[7]) discussed the production inventory model for deteriorating items to generate more selling opportunities in multiple market demands. This paper provides an optimum solution using a sensitivity analysis for management of raw material and finished goods. Singh, S, et al. (2011,[5]) developed an inventory model for decaying items with selling price dependent demand in inflationary environment. Ghosh et al. (2012,[2]) considered an optimal inventory replenishment policy for a deteriorating items time-quadratic demand and time- dependent partial backlogging which depends on the length of the waiting time for the next replenishment over a finite time horizon and variable replenishment cycle.

Julia et al. (2014, [3]) globalization has created many challenges for the business world. The expansion of business involves management of production process which in turn requires proper management and control of inventory. Some items of the inventory are subjected to fast rate of deterioration. Hence there is need to monitor an effective inventory planning and control. Bouras et al. (2015,[1]) studied three level stock categories for production system boosted by the effective advertisement policy of a firm. The three level stock systems involve manufactured items in the first category remanufacturing items in second category and third category has such inventory which is returned from the market. This paper provides an optimal solution to control the manufacturing, remanufacturing and disposal rate using sensitivity analysis. Yadav et al. (2015,[6]) studied an inventory model for that inventory which are subjected to continuous deterioration and have a maximum lifetime under two level trade credit period by using convex fractional programming to obtain an optimum solution at reduced inventory cost. Shah et al. (2016,[4]) analysed the problem of handling imperfect product quality which is exposed to deterioration at a constant rate. They also examined the different challenges that a retailer faces. This paper aims to develop a model based on advanced preservation technology to maximize profit of the retailer using a sensitivity analysis.

The proposed model by which an optimum solution is derived as a new approach for those items whose demand changes with time and have a constant deterioration rate.

How-ever in real life situation there is inventory loss by deterioration, also a great deal of effort has been focused on the modeling of the production planning problem in deterministic environment. The assumption of a constant demand rate may not be always appropriate for consumer goods such as milk, meat, vegetables, radioactive materials, volatile liquids, etc. as inventory has a negative impact on demand due to loss of consumer confidence about the production quality. Hence in formulating inventory model two factors have been of growing interest, first deterioration of items and second variation in the demand rate with time. Here we are trying to propose inventory model for deteriorating items with logarithmic demand and a unique optimal cycle time exists to minimize the annual total relevant cost.

The rest of the paper is organized as follows: Section 2 represents the assumptions and notations and section 3 represents problem formulation. Finally, the paper summarizes and concludes in section 4.

II. PROBLEM DEFINITION, ASSUMPTIONS AND NOTATION

2.1 Assumption: The following assumption are used to formulate the problem.

1. The initial inventory level is zero.

2. Lead time is zero.

3. Demand rate is logarithmic where $D=Ae^{\alpha t}$ where $\alpha > 0$, $t > 0$ at time t and it is continuous function of time. Here α is a constant.

4. The deteriorating item is constant.

5. The planning horizon is finite.

6. There is no repair or replacement of the deteriorated items.

7. Items are produced / purchased and added to the inventory and the item is a single product; it does not interact with any other inventory items.

8. The production rate is always greater than or equal to the sum of the demand rate.

II. 2.2 NOTATION:

The following notation are used in our Analysis

1. P-Production rate in units per unit time.

2. Q*-Optimal size of production run.

3. Cp Production Cost per unit.

4. θ-rate of deterioration.

5. Cd- deterioration cost per unit.

6. C0-SetupCost/ Ordering Cost.

7. Ch-holding cost per unit/year.

8. T-Cycle time.

9. t1-Production time.

10. TC-Total Cost.

III. MATHEMATICAL MODEL

3.1 DEVELOPMENT OF MATHEMATICAL MODEL

Let us consider a two-stage production-inventory cycle [0, T] of cycle time T(T>0) as shown in Figure 1. It shows inventory level I(t) at time t(t≥0) for two stages of the cycle, namely the production stage and the consumption stage. Considering the production time t1(0≤t≤t), the production stage covers the period $[0,t_1]$ and the consumption stage covers the period $[t_1, T]$ or $t_1 \leq t \leq T$.

This figure represents break up of time when the demand gets reduced

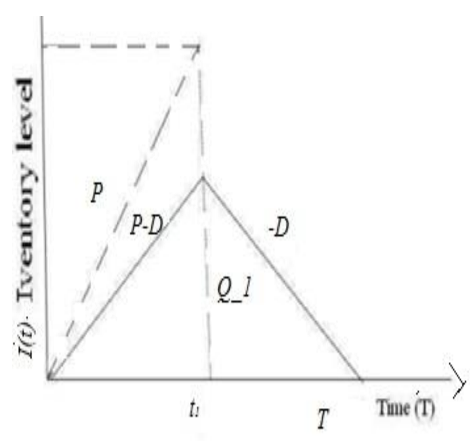

Figure 1: Production-inventory cycle

3.2 Production period $[0, t_1]$

The production period $[0, t_1]$ is defined as the time taken for the production of desired unit. During this stage, the inventory of items increases due to production at a rate of P items per unit of time but decreases due to demand at rate D items per unit of time. Here we are interested in logarithmic demand of D=log(a+bt) where a,b≥0 is a constant. Note that D is a continuous function of time t. With boundary conditions I(0)=0,I(T)=0, and $I(t_1)=Q_1$, and a deterioration rate of θ(0<θ<1), the rate at which inventory changes with respect to time over the production period is given by

$$\frac{dI(t)}{dt}+\theta I(t)=P-\log(a+bt) \quad , for\ 0\le t\le t_1 \quad (1)$$

Equation (1) simplify we get

$$\frac{dI(t)}{dt}+\theta I(t)=P-(\log a+\frac{bt}{a})$$

It is also known as inventory differential equation during production period.

During the consumption period $[t_1,T]$, no production occurs and subsequently reduction in the inventory level is due to deterioration items. If such problem arises in a definite time period then this means seasonal type problems and newspaper inventory type problems persist. For example, after Christmas the demand of cake and cookies get reduced. Also a hike in demand of cold drinks is seen in summer season. If there is less demand of items then items start deteriorating as soon as they are produced or after a certain period time.

The inventory differential equation during the consumption period with no production and subsequently reduction in the inventory level due to deterioration items is given by

$$\frac{dI(t)}{dt}+\theta I(t)=-\log(a+bt) \quad ; \quad t1\le t\le T \quad (2)$$

Figure 1 matches to this problem which represents that according to t1 time demand is decreased (We can say that preservative items like Jam, bread starts detonating at that time t1) and T represents complete cycle time. The solutions of differential equations given in (1) and (2) respectively are

$$I(t)=\frac{P}{\theta}-\frac{\log a}{\theta}-\frac{bt}{a\theta}+\frac{b}{a\theta^2}-\frac{P}{\theta e^{\theta t}}+\frac{\log a}{\theta e^{\theta t}}-\frac{b}{a\theta^2 e^{\theta t}}$$

for 0≤t≤t1 (3)

and

$$I(t)=\frac{-\log a}{\theta}-\frac{bt}{a\theta}+\frac{b}{a\theta^2}+\frac{\log a}{\theta}e^{\theta T-\theta t}+\frac{bT}{a\theta}e^{\theta T-\theta t}-\frac{b}{a\theta^2}e^{\theta T-\theta t} \quad for\ t_1\le t\le T$$

(4)

Because we know that $I_1(t)=I_2(t)$ at $t=t_1$, then from (3) and (4) we get. Compare that at time t1

$$\frac{P}{\theta}-\frac{\log a}{\theta}-\frac{bt_1}{a\theta}+\frac{b}{a\theta^2}-\frac{P}{\theta e^{\theta t_1}}+\frac{\log a}{\theta e^{\theta t_1}}-\frac{b}{a\theta^2 e^{\theta t_1}}$$
$$=$$
$$\frac{-\log a}{\theta}-\frac{bt_1}{a\theta}+\frac{b}{a\theta^2}+\frac{\log a}{\theta}e^{\theta T-\theta t_1}+\frac{bT}{a\theta}e^{\theta T-\theta t_1}-\frac{b}{a\theta^2}e^{\theta T-\theta t_1}$$

(5)

Simplify we get

$$\Rightarrow \frac{\log a}{\theta}e^{\theta T-\theta t_1}+\frac{bT}{a\theta}e^{\theta T-\theta t_1}-\frac{b}{a\theta^2}e^{\theta T-\theta t_1} = \frac{P}{\theta}-\frac{P}{\theta e^{\theta t_1}}+\frac{\log a}{\theta e^{\theta t_1}}-\frac{b}{a\theta^2 e^{\theta t_1}}$$

$$\Rightarrow \frac{p}{\theta}(e^{\theta t_1}-1)=\frac{\log a}{\theta}(e^{\theta T}-1)-\frac{b}{a\theta^2}(e^{\theta T}-1)+\frac{bT}{a\theta}e^{\theta T}$$

Expanding the exponential functions and neglecting that second and higher powers of

θ for small value of θ. Therefore

$$t_1=\frac{\log a\ T}{p}+\frac{bT^2}{aP}$$

∴ loga=A & b/a=B

$$t_1=\frac{A\ T}{p}+\frac{BT^2}{P}$$

$$t_1=\frac{(A+BT)T}{P}$$

3.3 Total Inventory Cost(TIC)

The total inventory cost (TIC) comprises of the ordering cost, holding cost and deteriorating cost, i.e. TIC = Ordering Cost + Holding Cost + Deteriorating Cost.

These costs are evaluated individually as follows:

Ordering Cost per unit time (O_c): Suppose $C_0$is the total set-up or ordering cost, then the ordering cost per unit time for a cycle over period [0,T] is given by $O_c = C_o/T$.

Holding Cost/unit per unit time H_C:

$H_C = \frac{C_h}{T}[\int_0^T I(t)\, dt]$ (6)

$HC = \frac{C_h}{T}[\int_0^{t_1} I_1(t)dt + \int_{t_1}^T I_2(t)dt]$

Since

$$\int_0^T I(t)dt = \int_0^{t_1} I_1(t)dt + \int_{t_1}^T I_2(t)dt$$

$$= \int_0^{t_1} \left(\frac{P}{\theta} - \frac{\log a}{\theta} - \frac{bt}{a\theta} + \frac{b}{a\theta^2} - \frac{P}{\theta e^{\theta t}} + \frac{\log a}{\theta e^{\theta t}} - \frac{b}{a\theta^2 e^{\theta t}}\right)dt +$$

$$\int_{t_1}^T \left(\frac{-\log a}{\theta} - \frac{bt}{a\theta} + \frac{b}{a\theta^2} + \frac{\log a}{\theta} e^{\theta T-\theta t} + \frac{bT}{a\theta} e^{\theta T-\theta t} - \frac{b}{a\theta^2} e^{\theta T-\theta t}\right)dt$$

$$= \left[-\frac{\log a\, t}{\theta} - \frac{bt^2}{2a\theta} + \frac{bt}{a\theta^2} - \frac{P}{\theta^2 e^{\theta t}} - \frac{\log a}{\theta^2 e^{\theta t}} + \frac{b}{a\theta^2 e^{\theta t}}\right]_0^{t_1} +$$

$$\left[-\frac{\log a\, t}{\theta} - \frac{bt^2}{2a\theta} + \frac{bt}{a\theta^2} - \frac{\log a\, e^{\theta T-\theta t}}{\theta^2} - \frac{bT e^{\theta T-\theta t}}{a\theta^2} + \frac{b\, e^{\theta T-\theta t}}{a\theta^3}\right]_{t_1}^T$$

$$\Rightarrow \frac{-\log a t_1}{\theta} - \frac{bt^2}{2a\theta} + \frac{bt}{a\theta^2} + \frac{p}{\theta^2 e^{\theta t_1}} - \frac{\log a}{\theta^2 e^{\theta t_1}} - \frac{b}{a\theta^3 e^{\theta t_1}} - \frac{p}{\theta^2} + \frac{\log a}{\theta^2} - \frac{b}{a\theta^3} + \frac{\log a t_1}{\theta} + \frac{bt_1^2}{2a\theta} - \frac{bt_1}{a\theta^2}$$

$$- \frac{\log aT}{\theta} - \frac{bT^2}{2a\theta} + \frac{bt}{a\theta^2} - \frac{\log a e^{\theta}}{\theta^2} - \frac{bT}{a\theta^2} + \frac{b}{a\theta^3} + \frac{\log a e^{\theta T-\theta t}}{\theta^2} + \frac{be^{\theta T-\theta t}}{a\theta^2} - \frac{be^{\theta T-\theta t_1}}{a\theta^3}$$

Taking approximate eθt=1+θt then we get

$$= \frac{\log aT}{\theta} - \frac{bT^3}{2a\theta} + \frac{\log a(1+\theta T-\theta t_1)}{\theta^2} + \frac{bT(1+\theta T-\theta t_1)}{a\theta^2} - \frac{b(1+\theta T-\theta t_1)}{a\theta^2} + \frac{P(1-\theta t_1)}{\theta^2} - \frac{\log a(1-\theta t_1)}{\theta^2} + \frac{b(1-\theta t_1)}{a\theta^2} - \frac{p}{\theta^2}$$

$$= \frac{-bT^2}{a\theta} - \frac{P}{\theta} t_1 - \frac{b}{a\theta^2} t_1 - \frac{bTt_1}{a\theta}$$

Using $t_1 = \frac{(A+BT)T}{P}$

Above equation it becomes

$$= \frac{-bT^2}{a\theta} - \frac{P}{\theta}\frac{(A+BT)T}{P} - \frac{b}{a\theta^2}\frac{(A+BT)T}{P} - \frac{bT}{a\theta}\frac{(A+BT)T}{P}$$

$$\int_0^T I(t)dt = \frac{-bT^2}{a\theta} - \frac{1(A+BT)T}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)T}{P} - \frac{bT}{a\theta}\frac{(A+BT)T}{P} \quad (7)$$

Now equation 6th (Holding Cost/unit)becomes

$$Hc = \frac{C_h}{T}\left[\frac{-bT^2}{a\theta} - \frac{1(A+BT)T}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)T}{P} - \frac{bT}{a\theta}\frac{(A+BT)T}{P}\right]$$

$$Hc = C_h\left[\frac{-bT}{a\theta} - \frac{1(A+BT)}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)}{P} - \frac{bT}{a\theta}\frac{(A+BT)}{P}\right]$$

$$Hc = -C_h\left[\frac{bT}{a\theta} + \frac{1(A+BT)}{\theta} + \frac{b}{a\theta^2}\frac{(A+BT)}{P} + \frac{bT}{a\theta}\frac{(A+BT)}{P}\right] \quad (8)$$

Deteriorating Cost/Unit time Therefore, DC

$$D_C = \frac{\theta C_d}{T}\left[\int_0^T I(t)dt\right] \quad (9)$$

We know that 7th eq.

$$\int_0^T I(t)dt = \frac{-bT^2}{a\theta} - \frac{1(A+BT)T}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)T}{P} - \frac{bT}{a\theta}\frac{(A+BT)T}{P}$$

Now equation 9th becomes

$$Dc = \frac{\theta C_d}{T}\left[\frac{-bT^2}{a\theta} - \frac{1(A+BT)T}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)T}{P} - \frac{bT}{a\theta}\frac{(A+BT)T}{P}\right]$$

$$Dc = \theta C_d\left[\frac{-bT}{a\theta} - \frac{1(A+BT)}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)}{P} - \frac{bT}{a\theta}\frac{(A+BT)}{P}\right]$$

$$Dc = -\theta C_d\left[\frac{bT}{a\theta} + \frac{1(A+BT)}{\theta} + \frac{b}{a\theta^2}\frac{(A+BT)}{P} + \frac{bT}{a\theta}\frac{(A+BT)}{P}\right]$$

Now

$$T_C = \frac{C_0}{T} + \frac{C_h + \theta C_d}{T}\left(\int_0^T I(t)dt\right)$$

$$T_C = \frac{C_0}{T} + \frac{C_h + \theta C_d}{T}\left[\frac{-bT}{a\theta} - \frac{1(A+BT)}{\theta} - \frac{b}{a\theta^2}\frac{(A+BT)}{P} - \frac{bT}{a\theta}\frac{(A+BT)}{P}\right] \quad (10)$$

For optimum condition

$$\frac{dT_C}{dT} = 0, \quad \frac{d^2T_C}{dT^2} > 0$$

Differentiate w.r.t T we get

$$\frac{dT_C}{dT} = \frac{-C_0}{T^2} + Ch+\theta Cd\left[\frac{-b}{a\theta} - \frac{b}{\theta} - \frac{b}{a\theta^2}\frac{B}{P} - \frac{bA}{a\theta P} - \frac{bB2T}{a\theta P}\right]$$

$$\frac{dT_C}{dT} = 0$$

$$\frac{-C_0}{T^2} + Ch+\theta Cd\left[\frac{-b}{a\theta} - \frac{b}{\theta} - \frac{b}{a\theta^2}\frac{B}{P} - \frac{bA}{a\theta P} - \frac{bB2T}{a\theta P}\right] = 0 \quad (11)$$

Now 11th becomes if we assume B=0

$$\frac{-C_0}{T^2} + Ch+\theta Cd\left[\frac{-b}{a\theta} - \frac{b}{\theta} - \frac{bA}{a\theta P}\right] = 0$$

$$T = \sqrt{\frac{a\,\theta\,P\,C_0}{b\,(C_h + \theta\,C_d)(P(-1-a) - A)}}$$

The above standard inventory model gives optimal Cycle time. If we run optimal cycle time then we get optimal solution. For the purpose of management of production inventory with reduced cost and maximize profit for deterioting items such as vegetable, milk, meat etc with logarithmic demand.

IV. CONCLUSION

In this section we provide some numerical results to illustrate the model. While going through the extensive review of the literature of different published papers on production inventory system of deteriorating items of both national and international level, it is found that most of the authors considered production uptime, maintenance time and inventory deterioration lost sales to find out optimal solution. Therefore, the work done by the researcher is based on the gap identified in the form of considering cycle time, breakup time and total inventory cost. But the present research reveals the impact of the above mentioned factors and it in lower cycle time calculation and gives breakeven point for such cases. Production is one of the most important function of a business organization group which strictly says that even a small increase in production time of each component may lead to huge losses in business. Thus, the production decisions are very important as they affect different aspects such as demand and supply of a product, inventory management, deterioration rate and deterioration cost. Availability of human resources and standardized tools along with the equipment's to accomplish the objective of minimum cost, minimum time and maximum output is one of the major challenges that a firm faces in production decision making. Thus, this study will help a business to make an optimum utilization of such deteriorating items to generate more profit at the minimum cost and time.

Appendix A (Programming of Numerical Examples)

```
Appendix A: #include<stdio.h>
#include<conio.h>
#include<math.h>
float formula();
void main()
{
      float T,A,B,theta,D,Oc,Hc,Dc,Ic;
      float C0,Ch,Cd;
      float t,a,b;
      long long int P;
      char ch;
      do

{
      printf("Want to enter values (Y/N)??");
      scanf("%c",&ch);
      switch(ch)
{
      case 'Y':
      case 'y':
      printf("Enter these values.\n");
      printf("P: ");
      scanf("%lld",&P);
      printf("A: ");
      scanf("%f",&A);
      printf("B: ");
      scanf("%f",&B);
      printf("a: ");
      scanf("%f",&a);
      printf("b: ");
      scanf("%f",&b);
      printf("Ch: ");
      scanf("%f",&Ch);
      printf("C0: ");
      scanf("%f",&C0);
      printf("Cd: ");
      scanf("%f",&Cd);
      printf("theta: ");
      scanf("%f",&theta);

 T=sqrt((a*theta*P*C0)/(b*(Ch+theta*Cd)*(P*(-1-a)-A)));
   t=((A+B*T)*T)/P;
   D=log(a+b*t);
   Oc=C0/T;

Hc=-
Ch*(((b*T)/(a*theta))+((A+B*T)/theta)+((b*(A+B*T))/(P*a*po
w(theta,2)))+(((b*T*(A+B*T))/(P*a*theta))));

Dc=-
theta*Cd*(((b*T)/(a*theta))+((A+B*T)/theta)+((b*(A+B*T))/(P
*a*pow(theta,2)))+(((b*T*(A+B*T))/(P*a*theta))));

Ic=Oc+Hc+Dc;
printf("\ttheta    demand    T     ordering_cost  holding_cost
deteriorating_cost  total_inventry_cost\t ");
//printf("-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
*-*-*\n");
printf("\n");
printf("\t%.4f  %f   %f   %f   %f      %f
%f",theta,D,T,Oc,Hc,Dc,Ic);
//printf("ordering cost= %f\nholding cost= %f\n",Oc,Hc);
//printf("deteriorating cost= %f\ntotal inventory cost=
%f\n",Dc,Ic);
printf("\n");
printf("-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
*-*\n");
      printf("\n\n");
      break;
      case 'N':
      case 'n':
      exit(0);
      default:
      printf("Please enter correct choice\n");
}
} while(1);
getch();
}
```


V. FUTURE SCOPE

NUMERICAL EXAMPLE

A manufacturing bakery company plans to use an approach in planning its annual production of 60,000 bakery. The set-up and ordering cost add to₹ 2,000 per set-up. The inventory carrying cost per month is established at 5% of the average inventory value. Each bakery costs of selling is ₹ 2000 in the market. Determine Demand, T(Cycle Time/ per unit of product),t1(production time(at this time demand decreases)/ break time), Setup Cost per unit , Deteriorating cost gear per unit and the total inventory costs.

Solution: Given P=60, 000 bakery per year, Co= ₹ 2,000 per unit/per year, Ch=5%of Rs 2000=Rs.1000 per year/per unit. CD=10,000 per year/per unit and D=log(a+bt) where a=10, b=-1. To find simple solution we take constant A=0.01.

$$T=\sqrt{\frac{a\,\theta\,P\,C_0}{b\,(C_h+\theta\,C_d)(P(-1-a)-A)}}$$

$$t_1=\frac{(A+BT)T}{P}$$

Figures and Tables

Table 1: Production inventory model for deteriorating items with logarithmic Demand

Deterioration rate θ	Demand (in bakery per unit/per year)	Cycle Time(T) per unit of bakery product	Production time/ break time t_1	Setup Cost per unit/per year	Holding Cost per unit/per year	Deteriorating cost bakery product per unit/per year	Total invento-ry cost per year
0.01	840.443525	0.128565	0.000214275	15556.34961	285.815552	28.581554	15870.74707
0.02	840.443525	0.174078	0.00029	11489.125	370.430145	74.086021	11933.6416
0.03	840.443525	0.204837	0.000341	9763.878906	349.47406	104.842216	10218.19531
0.04	840.443525	0.227921	0.00038	8774.964844	319.813385	127.925346	9222.703125
0.05	840.443525	0.246183	0.00041	8124.038574	292.372711	146.186356	8562.597656
0.06	840.443525	0.261116	0.000435	7659.416992	268.532166	161.119293	8089.068359
0.07	840.443525	0.273617	0.000456	7309.484863	248.027878	173.619522	7731.132324
0.08	840.443525	0.284268	0.000474	7035.624023	230.337173	184.269745	7450.230957
0.09	840.443525	0.29347	0.000489	6815.015625	214.968338	193.471512	7223.455566
0.1	840.443525	0.301511	0.000503	6633.249512	201.513062	201.513062	7036.275391

From the table 1, a study of rate of deteriorative items with cycle time, optimum quantity, setup cost, holding cost, deteriorating cost and total cost and it is concluded that when the rate of deteriorative items increases then the setup cost, deteriorating cost and total cost increases then it is positive relationship between them and the demand, cycle time, optimum quantity, holding cost decreases then there is negative relationship between them.

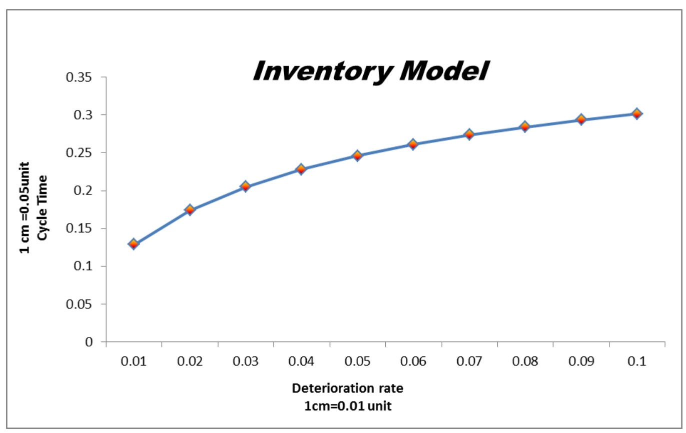

Figure 2: Inventory model, Cycle Time as a function of Deterioration rate for example

References

[1] Bouras, A., "Optimal control for advertised production planning in a three-level stock system with deteriorating items: Case of a continuous-review policy," *Arabian Journal for Science & Engineering, (Springer Science & Business Media BV), Vol.*40, Issue.9, 2015.

[2] Ghosh, S.K., Sarkar, T and Chaudhuri, K.S., "An optimal inventory replenishment policy for a deteriorating item with time-quadratic demand and time dependent partial backlogging with shortages in all cycles", *Applied Mathematics and Computation*, Vol.218, pp. 9147-9155, 2012.

[3] Julia Pahl, " Integrating deterioration and lifetime constraints in production and supply chain planning: A survey," *European Journal of Operational Research*, 238, 654–674, 2014.

[4] Shah, N.H. and Shah, A.D., "Optimal cycle time and preservation technology investment for deteriorating items with price-sensitive stock-dependent demand under inflation," *Journal of Physics: Conference series, Vol.*495, Issue.1, 2014.

[5] Sing , S. Dube , R and Singh, S.R., "Production model with selling price dependent demand and partially backlogging under inflation," *International journal of Mathematical Modelling & Computations* , Vol.1, Issue.1, pp.01-07, 2011.

[6] Yadav, D., Singh, S.R., Gupta, M. and Singh, D., " Manufacturing inventory model for deteriorating items with maximum lifetime under two-level trade credit financing," *International Journal of Computer Applications, Vol.*121, Issue.15, 2015.

[7] Yong, H., Wang, S., and Lai, K.K., "An optimal production-inventory model for deteriorating items with multiple-market demand," *European Journal of Operational Research*, Vol.203, pp.593–600, 2010.

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