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A Model for Optimal Reserve Inventory between Two Machines in Series with Repair time undergoes a parametric Change

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Abstract

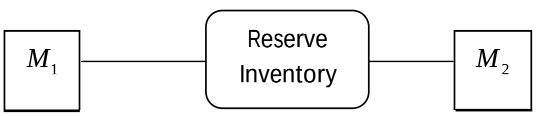
In inventory control theory, suitable models for various real life systems are constructed with the objective of determining the optimal inventory level. A new type of inventory model using the so-called Setting the Clock Back to zero(SCBZ) property is analyzed in this paper. There are two Machines M_1 and M_2 in series and the output of M_1 is the input for M_2 and hence in order to avoid the machine M_2 is being idle when the machine M_1 is in breakdown state, a reserve inventory is to be maintained between M_1 and M_2. The method of obtaining reserve $\hat{S}$, assume the cost of excess inventory, cost of shortage and rate of consumption of M_2 is constant is already attempted. In this paper it is assumed that the repair time of M_1 is a random variable and its distribution undergoes a parametric change after the truncation point and which is taken to be a random variable. The optimum reserve inventory is obtained under the assumption that the repair time having the SCBZ property. Numerical illustration is also discussed.

Key words: Reserve inventory, Truncation Point, SCBZ Property.

1. Introduction

A system, which has two machines M_1 and M_2 are in series is considered. The output of M_1 is the input of M_2. When the machine M_1 is in repair,it leads the machine M_2 to be idle. The idle time of M_2 is very costly and hence, to avoid the idle time of M_2, a reserve inventory is maintained in between M_1 and M_2. During the repair time of M_1, M_2 gets the input from reserve inventory and after the machine M_1 is getting repaired, it supplies to the reserve inventory[3-4].

The following diagram explains the system.



Notations:

h : Inventory holder cost permit and time.

d : Idle time const of M_2 per unit of time.

μ : Mean time interval between successive breakdowns of machine M_1, assuming exponential distribution of inter arrival times.

t : Continuous random variable denoting the repair time of M_1 with p.d.f $g(.)$ and $DFG(.)$.

r : Constant consumption rate of M_2 per unit of time.

S : Reserve inventory between M_1 and M_2.

T : Random variable denoting the idle time of M_2.

Since T is the random variable denoting idle time of M_2, it can be seen that

$$T = \begin{cases} 0 & \text{if } \frac{s}{r} > t \\ t - \frac{s}{r} & \text{if } \frac{s}{r} \leq t \end{cases} \qquad (1)$$

The expected total cost of inventory holding and idle time of M_2 permit time is

$$E(C) = hS + \frac{d}{\mu}\int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right)g(t)\,dt$$

The optimal reserve inventory can be obtained by setting the equation $\frac{dE(C)}{dS} = 0$.

The optimal reserve inventory is given by the expression $G\left(\frac{\hat{S}}{r}\right) = 1 - \frac{r\mu h}{d}$.

This result has been disturbed by Hansmann (1962).

2. Results

Model: I

In this model, it is assumed that the repair time of machine M_1 is a random variable and undergoes a parametric change. Thus the pdf of the repair time is given by

$$\begin{cases} g(t,\theta_1) & \text{if } t \le x_0 \\ g(t,\theta_2) & \text{if } t > x_0 \end{cases} \qquad (2)$$

Here x_0 is a truncation point and it is assumed to be a random variable distributed as uniform distribution with parameters *a* and *b*, $a < b$.

i.e., $x_0 \sim \bigcup(a,b)$

Sachithanantham *et.al.*[5] discussed this model, in which the truncation point x_0 assumed to be random variable as it follows exponential distribution.

Hence the p.d.f of repair time can be stated as

$$f(t) = g(t,\theta_1)\; p(t \le x_0) + g(t,\theta_2)\; p(t > x_0)$$

$$= g(t,\theta_1)\frac{b-t}{b-a} + g(t,\theta_2)\int_a^t g(t,\theta_2)\frac{1}{b-a}dx_0$$

$$\text{define} \begin{cases} g(t,\theta_1) = \theta_1 e^{-\theta_1 t} & \text{, if } t \le x_0 \\ g(t,\theta_2) = \theta_2 e^{-\theta_2 t} e^{x_0(\theta_2-\theta_1)}, & \text{if } t > x_0 \end{cases}$$

It can be proved that the distribution of repair time satisfies that so called $SCBZ$ property, discussed by Raja Rao and Talwalkar[2].

Model: II

It is observed that the random variable '*T* ' defined in equation (.) undergoes a parametric change, as above said, then the average idle time of M_2 is

$$E(T) = \int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right) f(t)\,dt$$

$$= \int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right) g(t,\theta_1)\frac{b-t}{b-a}dt + \int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right)\left[\left(\int_a^t g(t,\theta_2)\frac{1}{b-a}dx_0\right)\right]dt$$

The expected total cost

$$E(C) = hS + \frac{d}{\mu}\left[\int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right) g(t,\theta_1)\frac{b-t}{b-a}dt + \int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right)\left[\int_a^t g(t,\theta_2)\frac{1}{b-a}dx_0\right]dt\right]$$

$$= hS + \frac{d}{\mu}\left[\int_{\frac{s}{r}}^{\infty}\left(t - \frac{s}{r}\right)\theta_1 e^{-\theta_1 t}\,\frac{b-t}{b-a}dt + \int_{\frac{s}{r}}^{\infty}\left(1 - \frac{s}{r}\right)\left(\int_a^t e^{x_0(\theta_2-\theta_1)}.\theta_2 e^{-\theta_2 t}\,\frac{1}{b-a}dx_0\right)dt\right]$$

$$= hS + \frac{d}{\mu}\left[\frac{\theta_1}{b-a}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)e^{-\theta_1 t}\left(b-t\right)dt + \frac{\theta_2}{b-a}\int_{\frac{s}{r}}^{\infty}\left(1-\frac{s}{r}\right)e^{-\theta_2 t}\left(\int_a^t e^{x_0(\theta_2-\theta_1)}dx_0\right)dt\right]$$

$$= hS + \frac{d}{\mu}\left[\frac{\theta_1}{b-a}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)\left(b-t\right)e^{-\theta_1 t}dt + \frac{\theta_2}{b-a}\int_{\frac{s}{r}}^{\infty}\left(1-\frac{s}{r}\right)\frac{e^{-\theta_2 t}}{\theta_2-\theta_1}\left(e^{t(\theta_2-\theta_1)} - e^{a(\theta_2-\theta_1)}\right)dt\right]$$

$$= hS + \frac{d}{\mu}\left[\frac{\theta_1}{b-a}T_1 + \frac{\theta_2}{\left(b-a\right)\left(\theta_2-\theta_1\right)}T_2\right] \text{ say}$$

here

$$T_1 = \int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)\left(b-t\right)e^{-\theta_1 t}dt \quad \text{and}$$

$$T_2 = \int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)e^{-\theta_2 t}\left(e^{t(\theta_2-\theta_1)} - e^{a(\theta_2-\theta_1)}\right)dt$$

$$\frac{dE\left(C\right)}{ds} = 0 \Rightarrow h + \frac{d\cdot\theta_1}{\mu\left(b-a\right)}\frac{dT_1}{dS} + \frac{d\cdot\theta_2}{\mu\left(b-a\right)\left(\theta_2-\theta_1\right)}\frac{dT_2}{dS} = 0$$

It can be shown that

$$\frac{dT_1}{dS} = \frac{d}{dS}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)\left(b-t\right)e^{-\theta_1 t}dt$$

$$= 0 - \frac{1}{r}f\left(\frac{s}{r}-s\right) + \left[\int_{\frac{s}{r}}^{\infty}\left(-1/r\right)\left(b-t\right)e^{-\theta_1 t}dt\right]$$

$$= -1/r\int_{\frac{s}{r}}^{\infty}\left(b-t\right)e^{-\theta_1 t}dt$$

$$= \frac{-1}{r}\left[\left(b-t\right)\frac{e^{-\theta_1 t}}{-\theta_1} + \frac{e^{-\theta_1 t}}{-\theta_1^2}\right]_{\frac{s}{r}}^{\infty}$$

$$= \frac{-1}{r}\left[0 - \left(\frac{\left(b-\frac{s}{r}\right)}{-\theta_1} + \frac{1}{\theta_1^2}\right)e^{-\theta_1\frac{s}{r}}\right]$$

$$=\frac{1}{r}\left[e^{-\theta_1\frac{s}{r}}\left(\frac{1}{\theta_1^2}-\frac{\left(b-\frac{s}{r}\right)}{\theta_1}\right)\right]$$

$$=\frac{1}{r\theta_1^2}e^{-\theta_1\frac{s}{r}}\left[1-\theta_1\left(b-\frac{s}{r}\right)\right]$$

$$\frac{dT_2}{dS}=\frac{d}{dS}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)e^{-\theta_2 t}\left(e^{t\theta_2-t\theta_1}-e^{a(\theta_2-\theta_1)}\right)dt$$

$$=\frac{d}{dS}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)\left[e^{-t\theta_1}-e^{-\theta_2 t}e^{a(\theta_2-\theta_1)}\right]dt$$

$$=\frac{1}{r}\int_{\frac{s}{r}}^{\infty}\left[e^{-t\theta_1}-e^{-\theta_2 t}e^{a(\theta_2-\theta_1)}\right]dt$$

$$=\frac{1}{r}\left\{e^{a(\theta_2-\theta_1)}\left[\frac{e^{-\theta_2 t}}{-\theta_2}\right]_{\frac{s}{r}}^{\infty}-\left[\frac{e^{-t\theta_1}}{-\theta_1}\right]_{\frac{s}{r}}^{\infty}\right\}$$

$$=\frac{1}{r}\left\{e^{a(\theta_2-\theta_1)}\left[\frac{0-e^{\frac{-s}{r}\theta_2}}{-\theta_2}\right]-\left[\frac{0-e^{\frac{s}{r}\theta_1}}{-\theta_1}\right]\right\}$$

$$1=\frac{e^{a(\theta_2-\theta_1)}}{r\theta_2}e^{\frac{-s}{r}\theta_2}-\frac{1}{r\theta_1}e^{\frac{-s}{r}\theta_1}$$

$$\frac{dE(c)}{dS}=0\Rightarrow h+\frac{d\theta_1 e^{-\theta_1\frac{s}{r}}}{\mu(b-a)r\theta_1^2}\left(1-\left(b-\frac{s}{r}\right)\theta_1\right)+\frac{d\theta_2}{\mu(b-a)(\theta_2-\theta_1)}\left[\frac{e^{a(\theta_2-\theta_1)}}{r\theta_2}e^{\frac{-s}{r}\theta_2}-\frac{e^{\frac{-s}{r}\theta_1}}{r\theta_1}\right]=0$$

$$\Rightarrow h+\frac{d\ e^{-\theta_1\frac{s}{r}}}{\mu(b-a)r\theta_1}\left\{1-\left(b-\frac{s}{r}\right)\theta_1\right\}+\frac{d\theta_2}{\mu(b-a)(\theta_2-\theta_1)r}\left\{\frac{e^{a(\theta_2-\theta_1)}}{\theta_2}e^{\frac{-s}{r}\theta_2}-\frac{e^{\frac{-s}{r}\theta_1}}{\theta_1}\right\}=0$$

$$\Rightarrow h+de^{-\theta_1\frac{s}{r}}\left\{\frac{\left[1-\left(b-\frac{s}{r}\right)\theta_1\right]}{\mu(b-a)r\theta_1}-\frac{\theta_2}{\theta_1\mu(b-a)(\theta_2-\theta_1)r}\right\}+\frac{d\theta_2}{\mu(b-a)(\theta_2-\theta_1)r}\left\{\frac{e^{a(\theta_2-\theta_1)}}{\theta_2}e^{\frac{-s}{r}\theta_2}\right\}=0$$

$$\Rightarrow h-\frac{d}{\mu(b-a)r}\left\{e^{-\theta_1\frac{s}{r}}\left[\frac{1-\left(b-\frac{s}{r}\right)\theta_1}{\theta_1}-\frac{\theta_2}{\theta_1(\theta_2-\theta_1)}\right]-\frac{e^{a(\theta_2-\theta_1)}}{(\theta_2-\theta_1)}e^{\frac{-s}{r}\theta_2}\right\}=0$$

$$=> h-\frac{d}{\mu(b-a)r}\left\{e^{-\theta_1\frac{s}{r}}\left[\frac{\theta_2}{\theta_1(\theta_2-\theta_1)}-\frac{1-\left(b-\frac{s}{r}\right)\theta_1}{\theta_1}\right]-\frac{e^{a(\theta_2-\theta_1)}}{(\theta_2-\theta_1)}e^{-\frac{s\theta_2}{r}}\right\}=0$$

$$=> \frac{h\mu r(b-a)}{d}=e^{-\theta_1\frac{s}{r}}\left[\frac{\theta_2}{\theta_1(\theta_2-\theta_1)}-\frac{1-\left(b-\frac{s}{r}\right)\theta_1}{\theta_1}\right]-\frac{e^{a(\theta_2-\theta_1)}e^{-\frac{s\theta_2}{r}}}{(\theta_2-\theta_1)}$$

$$=> \frac{h\mu r(b-a)}{d}=-\left\{e^{-\theta_1\frac{s}{r}}\left[\frac{1-\left(b-\frac{s}{r}\right)\theta_1}{\theta_1}-\frac{\theta_2}{\theta_1(\theta_2-\theta_1)}\right]+\frac{e^{a(\theta_2-\theta_1)}}{(\theta_2-\theta_1)}e^{\frac{-s}{r}\theta_2}\right\}$$

$$=> \frac{h\mu r(b-a)}{d}=-e^{-\theta_1\frac{s}{r}}\left[\frac{\theta_2}{\theta_1(\theta_2-\theta_1)}-\frac{1-\left(b-\frac{s}{r}\right)\theta_1}{\theta_1}\right]-\frac{e^{a(\theta_2-\theta_1)}e^{\frac{-s}{r}\theta_2}}{(\theta_2-\theta_1)}$$

$$=> \frac{h\mu r(b-a)(\theta_2-\theta_1)}{d}=e^{-\theta_1\frac{s}{r}}\left[\frac{\theta_2-\left[1-\left(b-\frac{s}{r}\right)\theta_1\right](\theta_2-\theta_1)}{\theta_1}\right]-e^{a(\theta_2-\theta_1)}e^{\frac{-s}{r}\theta_2}$$

$$=> \frac{h\mu r(b-a)(\theta_2-\theta_1)}{d}=\frac{e^{-\theta_1\frac{s}{r}}}{\theta_1}\left[\theta_2-\left[1-\left(b-\frac{s}{r}\right)\theta_1\right](\theta_2-\theta_1)\right]-e^{a(\theta_2-\theta_1)}e^{\frac{-s}{r}\theta_2}$$

$$=> \frac{h\mu r(b-a)(\theta_2-\theta_1)}{d}=\frac{e^{-\frac{s}{r}\theta_1}}{\theta_1}\left[\theta_1+\left(b-\frac{s}{r}\right)\theta_1(\theta_2-\theta_1)\right]-e^{a(\theta_2-\theta_1)}e^{-\frac{s}{r}\theta_2}$$

$$=> \frac{h\mu r(b-a)(\theta_2-\theta_1)}{d} = e^{-\frac{s}{r}\theta_1}\left[1+\left(b-\frac{s}{r}\right)(\theta_2-\theta_1)\right]-e^{a(\theta_2-\theta_1)}e^{-\frac{s\theta_2}{r}} \quad \text{(A)}$$

Using above equation the optimal $\hat{S}$ can be determined for the given values of constants $h,\ d,\ r,\ \mu,\ a,\ b,\ \theta_1$ and θ_2.

3. Alternative Method

$$E(C) = hs + \frac{d}{\mu}\int_{\frac{s}{r}}^{b}\left[\int_{\frac{s}{r}}^{b}\left(t-\frac{s}{r}\right)g(t,\theta_1)\,dt + \int_{x_0}^{\infty}\left(t-\frac{s}{r}\right)g(t,\theta_2)\,dt\right]\frac{1}{b-a}dx_0$$

$$+\frac{d}{\mu}\int_{a}^{\frac{s}{r}}\left[\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)g(t,\theta_2)\,dt\right]\frac{1}{b-a}dx_0$$

$$\frac{dE(C)}{dS} = 0 => h + \frac{d}{\mu}\int_{\frac{s}{r}}^{b}\frac{d}{dS}\left(\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}g(t,\theta_1)\right)+\int_{x_0}^{\infty}\left(t-\frac{s}{r}g(t,\theta_2)\,dt\right)\right)\frac{1}{b-a}dx_0$$

$$+\frac{d}{\mu}\int_{a}^{\frac{s}{r}}\left[\frac{d}{dS}\left(\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)g(t,\theta_2)\,dt\right)\right]\frac{1}{b-a}dx_0$$

$$h + \frac{d}{\mu}\int_{\frac{s}{r}}^{b} I_1 . \frac{1}{b-a}dx_0 + \frac{d}{\mu}\int_{a}^{\frac{s}{r}}\frac{d}{dS}I_2 . \frac{1}{b-a}dx_0 = 0$$

$$I_1 : \frac{d}{dS}\left[\int_{\frac{s}{r}}^{x_0}\left(t-\frac{s}{r}\right)\theta_1 e^{-\theta_1 t}dt + \int_{x_0}^{\infty}\left(t-\frac{s}{r}\right)\theta_2 e^{x_0(\theta_2-\theta_1)}e^{-\theta_2 t}dt\right]$$

$$= \frac{1}{r}\left[e^{-\theta_1 x_0} - e^{\frac{-s}{r}\theta_1}\right] - \frac{\theta_2 e^{x_0(\theta_2-\theta_1)}}{r}\left(\frac{0-e^{-\theta_2 x_0}}{-\theta_2}\right)$$

$$= \frac{1}{r}\left[e^{-\theta_1 x_0} - e^{-\frac{s}{r}\theta_1} - e^{-\theta_1 x_0}\right]$$

$$= -\frac{1}{r}e^{-\frac{s}{r}\theta_1}$$

$$I_2 : \frac{d}{dS}\int_{\frac{s}{r}}^{\infty}\left(t-\frac{s}{r}\right)\theta_2 e^{x_0(\theta_2-\theta_1)}\ e^{-\theta_2 t}dt$$

$$= \theta_2 e^{x_0(\theta_2-\theta_1)}\int_{\frac{s}{r}}^{\infty}\left(-\frac{1}{r}e^{-\theta_2 t}dt\right)$$

$$= -\frac{1}{r}e^{x_0(\theta_2-\theta_1)}e^{-\theta_2\frac{s}{r}}$$

$$\frac{dE(C)}{dS} = 0 \Rightarrow h + \frac{d}{\mu}\int_{\frac{s}{r}}^{b}\left(\frac{-1}{r}\right)e^{-\frac{s}{r}\theta_1}\frac{1}{b-a}dx_0 + \frac{d}{\mu}\int_{a}^{\frac{s}{r}}\left(\frac{-1}{r}\right)e^{x_0(\theta_2-\theta_1)}e^{-\theta_2\frac{s}{r}}\frac{1}{b-a}dx_0$$

$$\Rightarrow h - \frac{d}{\mu_r}\left[\int_{\frac{s}{r}}^{b} e^{-\frac{s}{r}\theta_1}\frac{1}{b-a}dx_0 + \int_{a}^{\frac{s}{r}} e^{x_0(\theta_2-\theta_1)}e^{-\theta_2\frac{s}{r}}\frac{1}{b-a}dx_0\right]$$

$$\Rightarrow h - \frac{d}{\mu_r(b-a)}\left[e^{-\frac{s}{r}\theta_1}\left(b-\frac{s}{r}\right) + \frac{e^{-\frac{s}{r}\theta_2}}{(\theta_2-\theta_1)}\left(e^{\frac{s}{r}(\theta_2-\theta_1)} - e^{a(\theta_2-\theta_1)}\right)\right]$$

$$\Rightarrow \frac{h\mu_r(b-a)}{d} = \left(b-\frac{s}{r}\right)e^{-\frac{s}{r}\theta_1} + \frac{e^{-\frac{s}{r}\theta_2}}{(\theta_2-\theta_1)}\left(e^{\frac{s}{r}(\theta_2-\theta_1)} - e^{a(\theta_2-\theta_1)}\right)$$

$$\frac{h\mu_r(b-a)(\theta_2-\theta_1)}{d} = e^{-\frac{s}{r}\theta_1}\left\{\left(b-\frac{s}{r}\right)(\theta_2-\theta_1)+1\right\} - e^{-\frac{s}{r}\theta_2}e^{a(\theta_2-\theta_1)} \qquad \ldots \text{(B)}$$

It can be seen that the equation (A) and (B) are same and the optimal value of S can be obtained for fixed values of $h, d, r, \mu, \theta_1, \theta_2, a$ and b.

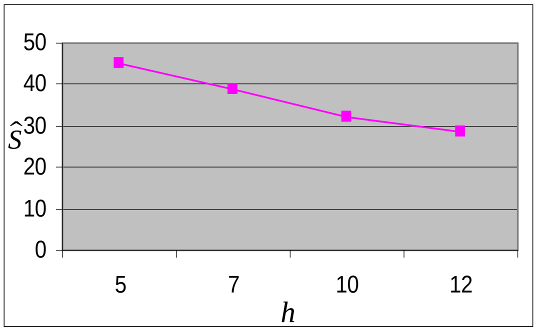
4. Numerical Illustration :

The variations of $\hat{S}$ studied for the changes in h, d, r, μ, a, b, θ_1 and θ_2 by taking numerical illustration. The tables and the corresponding graphs are given.

Case i:
The values of the constants are fixed arbitrarily, $d = 3000$, $r = 30$, $\mu = 2$, $a = 1$, $b = 5$, θ_1 =1.5, θ_2 =3 and the Optimal reserve $\hat{S}$ for various values of h.

H	$\hat{S}$
5	45.2714
7	39.0284
10	32.1698
12	28.5331

Optimal Reserve $\hat{S}$ for various values of *h*

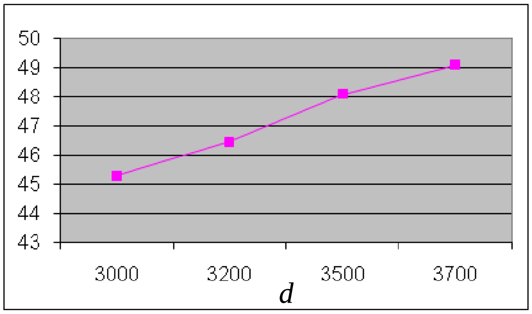


Case ii:

The values of the constants are fixed arbitrarily, h = 5, r = 30, μ = 2, a = 1, b = 5, θ_1 =1.5, θ_2 =3 and the Optimal reserve $\hat{S}$ for various values of d.

d	$\hat{S}$
3000	45.2714
3200	46.4506
3500	48.0812
3700	49.0825

Optimal Reserve $\hat{S}$ for various values of *d*

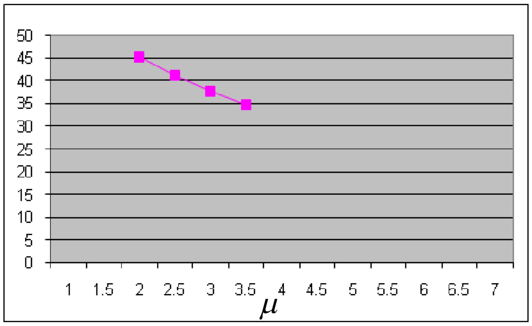


Case iii:

The values of the constants are fixed arbitrarily, h=5, d=3000, r =30, a = 1, b = 5, θ_1 =1.5 and θ_2 =3 and the Optimal reserve $\hat{S}$ for various values of μ .

μ	$\hat{S}$
2	45.2714
2.5	41.1509
3	37.7227
3.5	34.7724

Optimal Reserve $\hat{S}$ for various values of μ

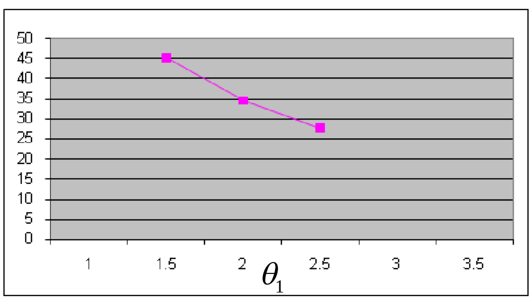


Case iv:

The values of the constants are fixed arbitrarily h=5, d=3000, r =30, μ = 2, a = 1, b=5 and θ_2 =3 and the Optimal reserve $\hat{S}$ for various values of θ_1.

θ_1	$\hat{S}$
1.5	45.27143
2	34.4947
2.5	27.62

Optimal Reserve $\hat{S}$ for various values of θ_1

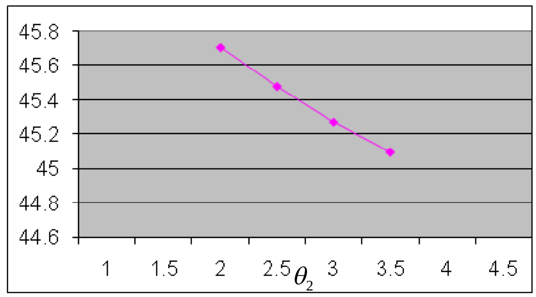


Case v:

The values of the constants are fixed arbitrarily h=5, d=3000, μ = 2, r =30, a = 1, b=5 and θ_1 =1.5 and the Optimal reserve $\hat{S}$ for various values of θ_2.

θ_2	$\hat{S}$
2	45.7065
2.5	45.4802
3	45.2714
3.5	45.0972

Optimal Reserve $\hat{S}$ for various values of θ_2

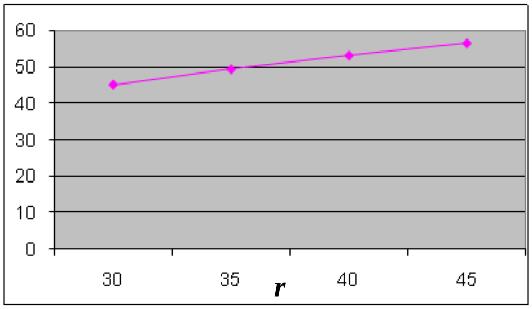


Case vi:

The values of the constants are fixed arbitrarily h=5, d=3000, μ = 2, a = 1, b=5, θ_1 =1.5 and θ_2 =3 and the Optimal reserve $\hat{S}$ for various values of r.

r	$\hat{S}$
30	45.2714
35	49.5013
40	53.2602
45	56.5876

Optimal Reserve $\hat{S}$ for various values of r



5. Conclusions

From the figures and Graphs it could be seen that as the value of carrying cost 'h' increases , $\hat{S}$ decreases and suggest smallest inventory.if the idle time cost 'd' increases , increases which is quit justifiable[1-3].

If the rate of consumption of M_2 increases, the $\hat{S}$ also increases and it suggest a larger inventory.As the value of μ, parameter of the distribution of the interarrival times between successive breakdowns of M_1 increases, then the average number of breakdowns per unit time decreases.Hence there is a decreases in the value of $\hat{S}$ and it is quit plausible[3-5].

As the value of θ_1 increases ,the parameter of the repair time distribution of m1 increases then the the average time to repairthe machine M_1 decreases.thus the repair time of machine M_1 is shorter and hence the optimal reserve inventory $\hat{S}$ decreases. A similar behavior in $\hat{S}$ is experienced when θ_2 increases[1-5].

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