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Research Design Considerations for Deteriorating Items of Inventory Models

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ABSTRACT

The first category deteriorating items refer to the items that become damages, decayed and lost of its marginal value evaporate, devaluation invalid, degradation and so on through time. The process of deterioration is happened in two categories of items that become damaged spoiled while the other category refer to the items that loss their parts of their total value through time because of the introduction of new technology or the alternatives like fashion and seasonal goods.

Keywords**:** manufacturing cost, setup cost, selling price

1. INTRODUCTION

The literature surveys by we shah and shas discuss the up discuss the up to date review on deteriorating inventory model. As on assumption that the buying or manufacturing company cost and its selling price of the item are constant through out all time and only the cost of the inventory management are of concern so in the p^{th} period, p = 1, 2, 3 ------ n.

di = amount demanded
i_p = interest charge pr unit of inventory carried forward to period p+1

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s_p = ordering cost like as the setup cost
x_p = amount ordered like as the manufacturing cost

So by the demands and cost are positive the problem is to find a program which need not be unique.

2. SOLUTION OF OPTIMIZATION PROBLEM BASED ON INVENTORY COST:

The method of solving the optimization problem is to enumerate 3^{N-1} combinations of either ordering or not ordering in each period consider I be the inventory and Io be the initial inventory for period p.

$$I = I_0 + \sum_{i=1}^{p-1} x_i - \sum_{i=1}^{p-1} d_i \geq 0$$

Becomes the representation of the minimal cost policy for periods p though period N then I is given by

$$f_p(I) = \underset{\substack{x_{p\geq 0} \\ I + x_p \geq d_p}}{Min} \left[i_{p-1} I + \delta(x_p) s_p + f_{p+1}(I + x_p - d_p) \right]$$

In which

$$\delta(x_p) = \begin{cases} 1 & \text{if} \quad x_p > 0 \\ 0 & \phantom{\text{if}} \quad x_p = 0 \end{cases}$$

although due to period N we may be written as

$$f_N(I) = \underset{\substack{x_{n\geq 0} \\ I + x_N \geq d_N}}{Min} \left[i_{N-1} I + f(x_N) \right] s_N$$

$$f_{p-1}(N) = \underset{\substack{x_{p-1} \geq 0 \\ 1 + x_{p-1} = d_{p-1}}}{Min} \left[i_{p-1} 1 + \delta(x_{p-1}) \delta_{p-1} + f_p(0) \right]$$

$$h_{p-1}(1) = \underset{\substack{x_{p-1} \geq 0 \\ 1 + x_{p-1} = d_{p-1}}}{Min} \left[i_{p-2} 1 + \delta(x_{p-1}) \delta_{p-1} \right]$$

Therefore from equation & we have minimal cost through P

$$F(p) = \min\left[\begin{matrix}\min \\ 1 \le i < p\end{matrix}\left[\delta_i + \sum_{g=l}^{p-1}\sum_{k=g+1}^{p} i_g d_k + F(i-1)\right]\right]$$

Consumes F(N) We shall have solved the problem for N is the lost period to be considered.

3. PRODUCTION LEVELS FOR INVENTORY HOLDING COST

This models involves planning horizon with m-equal periods. Each period has a limited production capacity that can include several produce levels with regular and over time representation of two production levels. A current period may produce more than its immediate demand to satisfy demand for later periods in which an inventory holding cost must be charged. So the general description of the model are as follows.

(a) Absence of setup cost is incurred in any period.
(b) Shortages is not allowed.
(c) Unit production cost function in any period either is constant or has increasing marginal cost
(d) Holding cost in any period is constant.

This assumption requires the cumulative production capacity of periods 1, 2, 3,……. and j to equal at least the cumulative demand for the same inclusive periods. Unit production cost function with increasing margins.

4. MATHEMATICAL INDUCTION MODEL FOR REPLENISHMENT RATE

Inventory problems for deteriorating items have been studied extensively be many scientists from day to day. The study of this research area is started with the consideration for deterioration at the end of prescribed storage period where $\propto$ be the constant decay in time and I be the inventory level with demand rate at time t.

$$\frac{dI(t)}{dt} + \propto I(t) = -f(t), 0 \le t \le T$$

$$f(t) = a + g(t)$$

$$I(0) = Q, I(T) = 0$$

$$I(t) = \frac{1}{\propto}\left[e^{\propto(T-t)}\left(a - \frac{g}{\propto} gT\right) - \left(a - \frac{g}{\propto} + gT\right)\right]$$

$$Q = I(0) = \frac{1}{\propto}\left[e^{\propto T}\left(a - \frac{g}{\propto} gT\right) - \left(a - \frac{g}{\propto}\right)\right]$$

$$= \frac{1}{\propto}\left[e^{\propto T}\left(a - \frac{g}{Q} + gT\right) - \left(a - \frac{g}{Q}\right)\right] - \frac{T}{2}(2a + gT)$$

The holding cost for first cycle is given by

$$\int_0^T (a + gt)\,dt = h\int_0^T I(t)\,dt$$

where: $h = ph_p$

$$= \frac{h}{\propto}\left[\left(\frac{a - \frac{g}{\propto} + bT}{\propto}\right)\left(e^{\propto T} - 1\right) - T\left\{a - \frac{g}{\propto} + \frac{gT}{\propto}\right\}\right]$$

$$\int_0^T \left(a + g(t)\,dt = \frac{h}{\propto T}\left[\frac{a - \frac{g}{\propto} + bT}{\propto}\left(e^{\propto T} - 1\right) - T\left(a - \frac{g}{\propto} + \frac{gT}{2}\right)\right]\right.$$

$$= \frac{pI_p}{\propto}\left[\left\{\frac{1}{\propto}\left(a - \frac{g}{\propto}\right) + \frac{1}{\propto} gT\right\}e^{\propto(T-M)} - 1\right\} - (T - M)\left\{a - \frac{g}{\propto} + \frac{g}{2}(T + M)\right\}\right]$$

$$= \frac{pI_p}{\propto T}\left[\frac{1}{\propto}\left(a - \frac{g}{\propto} + gT\right)\left\{e^{\propto(T-M)} - 1\right\} - (T - M)\left\{a - \frac{g}{\propto} + \frac{g}{2}(T + M)\right\}\right]$$

$$= \frac{pI_e}{T}\int_0^T tf(t)\,dt = PI_eT\left(\frac{a}{2} + \frac{gT^2}{2}\right)$$

Hence total variable cost per unit time in this step is

$$c_1(T) = \frac{A}{T} + \frac{P}{T}\left[\frac{1}{\propto}\left\{e^{\propto T}\left(a - \tfrac{g}{\propto} + gT\right) - \left(a - \tfrac{g}{\propto}\right)\right\} - \tfrac{T}{2}(2a + gT)\right]$$

$$+ \frac{h}{\propto T}\left[\frac{\left(a - \frac{g}{\propto} + gT\right)}{\propto}\left(e^{\propto T} - 1\right) - T\left\{a - \frac{g}{\propto} + \frac{gT}{2}\right\}\right] + \frac{PI_p}{\propto T}\left[\frac{1}{\propto}\left(a - \frac{g}{\propto} + gT\right)\right.$$

$$\left\{e^{\propto(T-M)}-1\right\}-(T-M)\left\{a-\tfrac{g}{\propto}+\tfrac{g}{2}(T+M)\right\}\Big]-PI_{pT}\left(\tfrac{a}{2}+\tfrac{gT^2}{3}\right)$$

with using $\frac{dc_1T}{dr}=0, \frac{d^2c_1(T)}{T^2}=0$ and $\frac{dc_1(T)}{dT}=0$ we obtained

$$2g\propto\left[p\propto+h+pI_pe^{-M}\right]T^2e^{\propto T}+2\propto\left[P\propto\left(a-\tfrac{g}{\propto}\right)+PI_p\left(a-\tfrac{g}{\propto}\right)e^{-\propto M}\right]$$

$$e^{\propto T}-\tfrac{4}{3}PI_pg\propto^2 T^2-\propto\left[g(h+p\propto)+paI_p\right]T^2+2\left(a-\tfrac{g}{\propto}\right)$$

$$\left[h+p\propto-pI_p\propto M+PI_p\right]-2\&\propto^2-pgI_p\propto M^2=0$$

Customers benefits integrates on the sales to the permissible delay period and no interest is payable during this time

$$PI_e\int_0^T(a+gt)tdt=PI_e\left(\tfrac{a}{2}T^2+\tfrac{g}{3}T^3\right)$$

and

$$PI_e(M-T)\int_0^T D(t)dt=PI_e\left(a+\tfrac{g}{2}T\right)(M-T)T$$

So during the second cycle the total interest earned

$$PI_e\left(\tfrac{a}{2}T^2+\tfrac{g}{3}T^3\right)+PI_e\left(a+\tfrac{g}{2}T\right)(M-T)T=PI_eT\left\{(gM-a)\tfrac{T}{2}-\tfrac{1}{6}gT^2+am\right\}$$

This different types of deterioration and optimal cycle lenth $T = T_2$ which optimized $c_2(T)$ is observed by solving equation using Necoton Raphson method which provided us

$$\frac{d^2c_2(T)}{dT^2}>0 \quad \text{we obtained}$$

$$q_0(T_2)=\tfrac{1}{\propto}\left[e^{\propto T_2}\left(a-\tfrac{g}{\propto}+gT_2\right)-\left(a-\tfrac{g}{\propto}\right)\right]$$

and

$$q_0(M)=\tfrac{1}{\propto}\left[e^{\propto M}\left(a-\tfrac{g}{\propto}+gM\right)-\left(a-\tfrac{g}{\propto}\right)\right]$$

Introduced damaging rate is exponential and unsatisfied items will completely backlogging and solving this mathematical model applied simulation model.

5. MODEL SITUATIONS OF INVENTORY CONTINUOUS DEMAND

In this model we assumed that the supplier must be paid for the items as soon as the items are received however in practice this may not true and usually there is no charge if the outstanding amount is settled within the permitted fixed settlement period so let us assume the random variable x and y to be independent so that the joint probability density junction p_x, p_y let C (Im) represent the total expected cost per unit obtaining the cost we product it with each other situations therefore the expected cost per unit time.

$$C(LM)=\sum_{y=0}^{\mathrm{Im}}\sum_{x=0}^{IM-y}C_1\left(IM-y-\tfrac{x}{2}\right)p_xp_y+\sum_{y=0}^{\mathrm{Im}}\quad\sum_{x=IM-y+1}^{\infty}\tfrac{1}{2x}\Big[C_1(\mathrm{Im}-y)^2+C_2(x$$

$$+y-\mathrm{Im})^2\Big]p_xp_y+\sum_{y=\mathrm{Im}+1}^{\infty}\sum_{x=0}^{\infty}c_2\left[\tfrac{x}{2}+y-IM\right]p_xp_y+A_{xy}$$

How C(Im) will be minimum if $\delta c(\mathrm{Im})>0>\delta C(\mathrm{Im}-1)$ where $\delta C(\mathrm{Im})C(\mathrm{Im}+1)-C(\mathrm{Im})$.

The summation of xy plane divide into parts as

$$\lambda_1(x,y,z)c_1\left(\mathrm{Im}-y-\tfrac{x}{2}\right)p_xp_y+A_{xy}$$

$$\lambda_2(x,y,z)=\frac{1}{2x}\left[c_1(\mathrm{Im}-y)^2+c_2(x+y-\mathrm{Im})^2\right]p_xp_y+A_{xy}$$

$$\lambda_3(x,y,z)=c_2\left(\tfrac{x}{2}+y-\mathrm{Im}\right)p_xp_y+A_{xy}$$

$$b(z)=\mathrm{Im},C(y,z)=\mathrm{Im}-y\quad\text{and}\quad d(y,z)=\infty$$

$$\delta(CI_m)=\sum_{y=0}^{\mathrm{Im}}\sum_{x=0}^{\mathrm{Im}-y}C_1P_xP_y+\sum_{y=0}^{\mathrm{Im}}\sum_{x=I\,m-y+1}^{\infty}\tfrac{1}{x}\left[(c_1+c_2)\left(I_m-y+\tfrac{1}{2}\right)-c_2x\right]p_xp_y-\sum_{y=1m+1}^{\infty}\sum_{x=0}^{\infty}c_2p_xp_y+A_{xy}$$

$$+\sum_{y=0}^{\infty}\sum_{x=1\,m-y+1}^{\infty}\Big[c_1\left(\mathrm{Im}-1-y-\tfrac{x}{2}\right)-\tfrac{c_1}{2x}(\mathrm{Im}+1-y)^2+\tfrac{c_2}{2x}(x+y-\mathrm{Im}-1)^2\;p_xp_y$$

$$+\sum_{y=1m+1}^{im+1}\sum_{x=0}^{\mathrm{Im}-y+1}c_1\left(\mathrm{Im}+1-y-\tfrac{x}{2}\right)p_x+\sum_{x=1m-y+2}^{\infty}\Big\{\tfrac{c_1}{2x}(\mathrm{Im}+1-y)^2+$$

$$\tfrac{c_2}{2x}\left(x+y-\mathrm{Im}-1\right)^2\Big\}p_x-\sum_{x=0}^{\infty}c_2\left(\tfrac{x}{2}+y-\mathrm{Im}-1\right)p_xp_y$$

$$\delta c(\mathrm{Im}) = c_1 \sum_{y=0}^{\mathrm{Im}} \sum_{x=0}^{\mathrm{Im}-y} p_x p_y + \sum_{y=0}^{\mathrm{Im}} \sum_{x=\mathrm{Im}-y+1}^{\infty} \tfrac{1}{x}\left[(c_1+c_2)\left(\mathrm{Im}-y+\tfrac{1}{2}\right) - c_2 x\right] p_x p_y - c_2$$

$$\sum_{y=\mathrm{Im}+1}^{\infty} \sum_{x=0}^{\infty} p_x p_y$$

$$\delta c(\mathrm{Im}) = c_1 \sum_{y=0}^{\mathrm{Im}} \sum_{x=0}^{\mathrm{Im}-y} p_x p_y + (c_1+c_2) \sum_{y=0}^{\mathrm{Im}} \sum_{x=\mathrm{Im}-y+2}^{\infty} \tfrac{1}{x}\left(\mathrm{Im}-y+\tfrac{1}{2}\right) p_x p_y - c_2 \sum_{y=0}^{\infty} p_y$$

$$\left[\sum_{y=0}^{\infty} p_x - \sum_{x=0}^{\mathrm{Im}} p_x\right] - c_2 \left[\sum_{y=0}^{\infty} \sum_{x=0}^{\mathrm{Im}} p_x p_y - \sum_{y=0}^{\mathrm{Im}} \sum_{y=0}^{\infty} p_x p_y\right]$$

$$\delta^2 c(\mathrm{Im}) = c_1 \sum_{y=0}^{\mathrm{Im}} \sum_{x=0}^{\mathrm{Im}-y} \delta\left(p_x p_y\right) + (c_1+c_2) \sum_{y=0}^{\mathrm{Im}} \quad \sum_{x=\mathrm{Im}-y+2}^{\infty} \delta\left\{\tfrac{1}{x}\left(\mathrm{Im}-y+\tfrac{1}{2}\right) p_x p_y\right\}$$

$$-c_2 \delta \left[\sum_{y=0}^{\infty} \sum_{x=0}^{\mathrm{Im}} p_x p_y - \sum_{y=0}^{\mathrm{Im}} \sum_{y=0}^{\infty} p_x p_y\right]$$

6. CONCLUSION

In this chapter we study the inventory model for deteriorating items with linear time dependent demand rate, and proposed an inventory replenishment policy for this type of inventory model. Thus this chapter provides interesting topics for the various further study of such kind of inventory models and thus the two models are equally as costly. If the Newton rapshon method and square root formula had not resulted in the ordering of supply, the costs under the two methods would have been different due to the discrete division of time in this model.

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