Name :- Anand Gautam

Roll no :- 19010401l

Branch :- CSE

Topic :- Operation Reserch Assignment (Unit-4)

Q:1→ Describe the systematic approach to the equipment replacement programme. State the advantages of sound equipment replacement programme.

Sol$^{n}$ :- The replacement problems are concerned with the situations that arise when performace of machine or equipments decreases with time or failure or breakdown. This decreases ~~with~~ efficiency/performances or complete breakdown may be either gradual or sudden.

Equipment Replacement :-

The replacement of productive equipment is important strategic decisions faced by both manufacturing and service firms securing purchasing a new piece of equipment often involves more cost and can affect the productivity.

The main concept is to replace the equipment replacement problem emphasises the physical deteriorations of products. The main concept is to replace the equipment when the cost

of operating & maintaining it become sufficient high.

Advantages of sound equipment replacement:-

(i) It will provide decreased taxes & increased productivity.

(ii) Better Quality, better image, leading to better observation.

(iii) Newer equipment uses less water less gas & produces more good per hour than older equipment.

Q:2:→ Define inventory. What are various types of inventory? Why they are maintained?

Sol$^{n}$:- An inventory can be defined as a stock of goods which is held for the purpose of future production or sales. The stock of goods may be kept in form of raw material, partly finished items, finished (or prepared) goods, spare parts, etc.

Types of Inventory:-

(i) Raw material → Raw material are material company uses to create & finish products

(ii) Components → Components are similar to ~~new~~ raw material in that they are the material a company uses to create & finish products except that they

remain recognizable when the product is completed.

(iii) Work in progress :- Work in progress inventory refers to items in production & includes raw material or components, labour, overhead, etc.

(iv) finished goods :- Finished goods are items that are ready to sell.

(v) Maintainance repair & operations (MRO) goods :- MRO is inventory often in the form of supplies that supports making a product or the maintainance of a product.

(vi) Packing & Packaging Materials :- There are 3 types of packing material. Primary packing protects the product & makes it usable. Secondary packing is the packing of finished good & can ~~neve~~ include labels or SKU information.

(vii) Safety Stock & Anticipation Stock :-

Safety stock is the extra inventory a company buys & stores to cover unexpected events. It has carrying costs, but it supports customer satisfaction.

(viii) Cycle Inventory :- Companies order cycle inventory in lots to get the right ~~answer~~ amount of stock for the lowest storage cost.

Q.4. Derive a formula for economic order quality (EOQ) for an inventory model with uniform demand.

Sol$^{n}$:-4:- Purchase cost → This is the variable cost of good = PXD

P = purchase unit price

D = annual demand quantity.

Ordering cost → Cost of placing order

K = each order cost

$\frac{D}{Q}$ = no. of times order is placed.

ordering cost = $K \times \frac{D}{Q}$

Holding Cost → Avg. quantity in stock = $Q/2$

cost = $h \times \frac{Q}{2}$

Total cost = Purchasing cost + ordering cost + holding cost.

$$T = PD + \frac{KD}{Q} + \frac{hQ}{2}$$

where Q = order quality

h = annual holding cost

differentiating to Q

$$\frac{dT}{dQ} = \frac{d}{dQ}(PD) + \frac{d}{dQ}\left(\frac{KD}{Q}\right) + \frac{d}{dQ}\left(\frac{kQ}{2}\right)$$

$$0 = \frac{-KD}{Q^2} + \frac{h}{2}$$

$$\frac{KD}{Q^2} = \frac{h}{2}$$

$$Q = \sqrt{\frac{2DK}{h}}$$

This is optimal order quantity.

So, $T = PD + KD\sqrt{\frac{h}{2DK}} + \frac{h}{2}\sqrt{\frac{2DK}{h}}$

This is optimal cost.

**Soln: 5 →**

annual demand of item = 3200 unit

cost of 1 units = ₹ 6

Holding cost, h = 25%

cost of one order, K = 150

$h = 0.25 \times 6 = \frac{6}{4} = ₹ 1.5$

$$EOQ = \sqrt{\frac{2 \times D \times K}{h}} = \sqrt{\frac{2 \times 3200 \times 150}{1.5}}$$

**EOQ = 800 units**

No. of order/year $= \frac{P}{EOQ} = \frac{3200}{800} = 4$

Optimal cost $T = PXD + \frac{KP}{Q} + \frac{hQ}{2}$

$\Rightarrow 6 \times 3200 + \frac{150 \times 3200}{800} + \frac{1.5}{2} \times 800$

$\Rightarrow 19200 + 600 + 600$

$\Rightarrow 20,400$

**Sol$^{n}$:-7:-**

Demand annual $D = 600$ unit/year

cost of 1 unit, $P = ₹50$/unit

cost of order, $K = ₹5$/order

Inventory cost, $h = 0.25 \times 50 = 12.5$/unit

Storage cost $= ₹12$/year

$$EOQ = \sqrt{\frac{2 \times D \times K}{h}} = \sqrt{\frac{2 \times 600 \times 5}{12.5}}$$

$$\boxed{EOQ \simeq 22 \text{ unit}}$$

## Sol$^n$:- 8:-

| Year | Maintenance Cost | Total Main. cost | Resale | C-Cost | Total machine cost | Cost/yr. |
|---|---|---|---|---|---|---|
| 1 | 1000 | 1000 | 3000 | 3000 | 4000 | 4000 |
| 2 | 1200 | 2200 | 1500 | 4500 | 6700 | 3350 |
| 3 | 1400 | 3600 | 750 | 5250 | 8850 | 2950 |
| 4 | 1800 | 5400 | 375 | 5625 | 11025 | 2756.25 |
| 5 | 2300 | 7700 | 200 | 5800 | 13500 | 2700 |
| 6 | 2800 | 10500 | 200 | 5800 | 16300 | 2716.6 |
| 7 | 3400 | 13900 | 200 | 5800 | 19700 | 2814.3 |
| 8 | 4000 | 17900 | 200 | 5800 | 23700 | 2962.5 |

Machine should be replaced at the end of 5$^{th}$ year.

## Sol$^n$: 9-

Annual Demand $D = 12000$ unit/yr

Manufacturing = $2000 \times 12$ item/yr.

Holding cost, $h = 0.15 \times 12$ /unit.

Cost of 1 unit, $P = 4$

Cost of one setup, $K = ₹400$

$$EOQ\ (Q^*) = \sqrt{\frac{2DK}{h}} = \sqrt{\frac{2 \times 12000 \times 400}{0.15 \times 12}}$$

$$= \sqrt{\frac{2 \times 400 \times 1000}{0.15}}$$

$$\boxed{EOQ = 2309.4 \text{ unit}}$$

Total cost, $T = 4 \times 12000 + \frac{400 \times 12000}{Q^*} + 0.15 \times 12 \times \frac{Q^*}{2}$

$\Rightarrow 48000 + 2078.46 + 2078.46$

$$\boxed{T = ₹\,52156.92}$$

Manufacturing time $= \frac{12000}{2000}$

$\Rightarrow$ 6 months.

Sol$^n$ -10 :-

| year | Cost of M/c | Maintainance cost | Total M/c cost | Cost/yr. |
|---|---|---|---|---|
| 1 | 9000 | 200 | 9200 | 9200 |
| | | 2200 | 11200 | 5600 = B |
| 2 | 9000 | 4200 | 13200 | 4400 |
| 3 | 9000 | 6200 | 15200 | 3800 |
| 4 | 9000 | | | |

Avg cost/yr. of 3rd yr. < Maintaence cost of 4th yr.

we should replace machine A at end of 3rd year.

for Machine B

| Year | Cost | Maintenance | Total | Avg. cost |
|---|---|---|---|---|
| 1 | 10000 | 400 | 10,400 | 10400 |
| 2 | 10000 | 1200 | 11200 | 5600 |
| 3 | 10000 | 2000 | 12000 | 4000 <A |

So, we should replace A by at the end of 2nd year.

Soln-13:-

| Month | C.F (surving) | % failure/ week | Probability of failure. |
|---|---|---|---|
| 1 | 97 | 3 | 0.03 |
| 2 | 90 | 7 | 0.07 |
| 3 | 70 | 20 | 0.20 |
| 4 | 30 | 40 | 0.40 |
| 5 | 15 | 15 | 0.15 |

Expected life = $\Sigma x_i P_i$ = $0.03 \times 1 + 0.07 \times 2 + 0.20 \times 3 + 0.40 \times 4 + 0.15 \times 5$

Avg. no. of failure/ month = $\frac{10000}{4.02} = 2488$

Cost of individual Replacement = ₹ 2488

## Group Replacement

$N_0$ = No. of resistors in begining = 10,000

$N_1$ = No. of resistors at the end of first month.

$N_1 = N_0 P_1 = 10000 \times 0.03 = 300$

$N_2$ = No. of resistors replaced at the end of second month

$N_2 = N_0 P_2 + N_1 P_1$

$= 10000 \times 0.07 + 300 \times 0.03$

$N_2 = 709$

$N_3 = N_0 P_3 + N_1 P_2 + N_2 P_1$

$= 10000 \times 0.2 + 300 \times 0.07 + 709 \times 0.03$

$N_3 = 2042$

$N_4 = N_0 P_4 + N_1 P_3 + N_2 P_2 + N_3 P_1$

$N_4 = 10000 \times 0.4 + 300 \times 0.2 + 709 \times 0.07 + 2042 \times 0.03$

$N_4 = 4171$

Similarly $N_5 = 2030$.

| End of Month | Individual Replacement | Total Cost Individual + Group | Avg. Cost. |
|---|---|---|---|
| 1 | 300 | 300×1+10000×0.35 | 3800 |
| 2 | 300+709 | 1009×1+10000×0.35 | 2254.5 |
| 3 | 1009+2042 | 3051×1+10000×0.35 | 2183.67 |
| 4 | 3051+4171 | 7222×1+10000×0.35 | 2680.5 |
| 5 | 7222+2030 | 9252×1+10000×0.35 | 2550 |

So group replacement is better.

Sol$^n$-14 :-

Annual Demand, $D = 16000$

Cost of each unit, $P = ₹2$

Cost of each order, $K = ₹45$

Holding cost, $h = 0.1 \times 2 = 0.2$

(i) $EOQ = \sqrt{\frac{2 \times D \times K}{h}}$

$= \sqrt{\frac{2 \times 16000 \times 45}{0.2}}$

$\boxed{EOQ = 2683.28}$

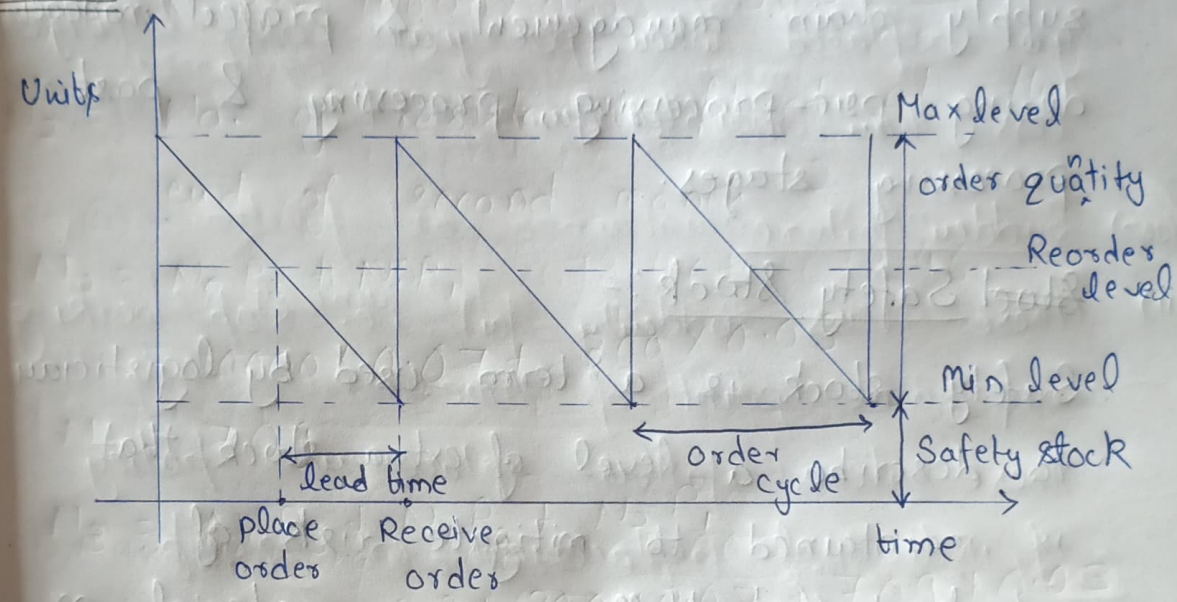
(ii) Total cost $= P.D + \frac{KD}{Q^*} + \frac{h}{2} \times Q^*$

$= 2 \times 16000 + \frac{45 \times 16000}{2683.28} + \frac{0.2}{2} \times 2683.2$

$\Rightarrow 32000 + 268.32 + 268.328$

**Total Cost = 32536.656**

Sol$^{n}$-15 :-




(i) **Order Quantity**

Order quantity is the order quantity that minimizes the total holding costs & ordering costs in investory management. It is one of the oldest classical production scheduling model.

It refers to optimal amount of inventory a company should purchase in order to meet it's demand while minimizing it's holding & storage cost.

(ii) Lead time :-

Lead time is the amount of time that passes from the start of a process until it's conclusion.

Companies review lead time in manufacturing, supply chain management, & project management during pre-processing, processing & post-processing stages.

(iii) ~~Stock~~ Safety Stock :-

Safety stock is a term used by logisticians to describe a level of extra stock that is maintained to mitigate risk of stockouts (shortfall in raw material or packaging) causing by uncertainities in supply & demand. Adequate safety stock level permit business operation to proceed according to their plans.

(iv) Re-order point :-

The reorder point is the level of inventory which trigger an action to replenish that particular inventory stock. It is a minimum amount of an item which a firm hold in stock such that when stock facts to this amount the item must be reordere