(1)

Sequence of the Subject (weitage 6+07 marks)

14-03-21

1. Introduction and BEA
2. Inventory ★★ vimost Imp
3. Sequencing.
4. PERT, CPM ★★
5. Forecasting ★★
6. Line balancing
7. Queuing
8. Liner Programming ★★
   { – Graphical, Simplex
   – Transportation, Assignment }
9. MRP
10. PPC and plant layout

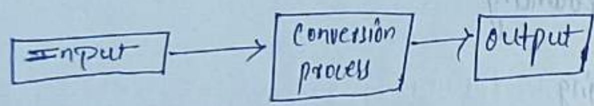
Imp. Books for Industrial if want to read or fo extra Numerical

O.P. Khanna, Mahajan,
Ravi Shankar

Production

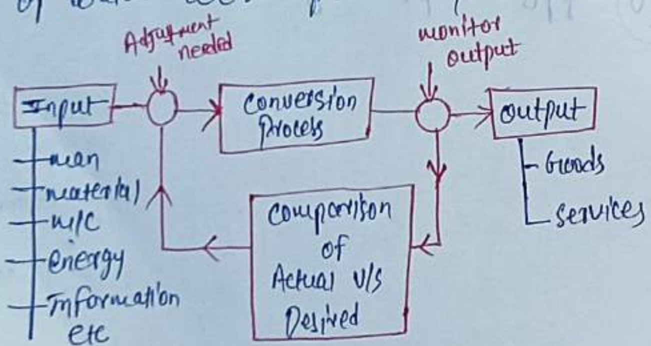
It is a step by step value addition ~~addit~~ process of converting one form of material into another form to increase the utility of the product for the user.

The product produced should be the need or neccessety of some-one and should've economic value.



Producion System:-

It is an organized process of converting Raw material into finished product with a feed-back loop which compare the difference b/w the actual product produced and the desired product of which we've planned Production System



Productivity:-

It is a quantitative ratio b/w what we produce and what we use as resources to produce them. every organisation always want to increase productivity by applying new technique and method.

$$\text{Productivity} = \frac{\text{output} (\uparrow)}{\text{Input} (\downarrow)}$$

Industrial engeer:-

It is concerned with design, installation and improvement of production system. it's objective is to eliminate unproductive operations in order to increase productivity.

Production manager:-

Production manager is concerned with planning, controlling, directing the day to day working of production system. It's objective is to produce goods and services of right quality and quantity at predetermined time and cost.

Cost in production :-

(1) Prime or Direct cost = Direct material + Direct Labour + Direct expenses.

(2) Factory overhead or Factory expenses = Indirect material + Indirect Labour + Indirect expenses.

Indirect material → Cutting fluid, Grease, Lubricant, Cotton, Jute, Stationary items etc.

Indirect Labour → watchman, supervisor, Higher officers etc.

Indirect expenses → Rent, Facility development, Telephone, electricity bills etc.

(3) Factory cost = Prime cost + Factory overhead.

(4) Total cost = Factory cost + marketting, ~~Advertisi~~ Advertising, storage, transportation cost etc.

(5) selling cost = Total cost + profit

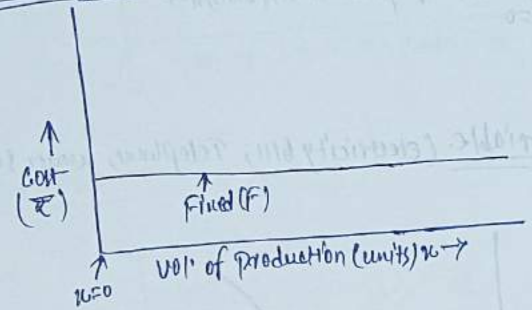
** (Very imp.) Breakeven analysis :-
- Total cost
- selling cost
- Vol. of product

It is an imp. tool used ~~by Production~~ by producer to analyse the potential profit or loss ... future

(1) Total cost :-

It indicates the expenditure required in order to produce certain no. of units and it is the sum of fixed and variable cost.

(a) Fixed cost (F)



Fixed cost: This cost may fixed or constant irrespective of vol. of production, It include salary of watchman, higher officers, rent of building, advertisement cost, setup cost of machine, insurance cost, Interest etc.

PTO

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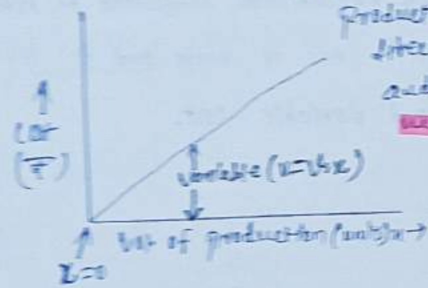
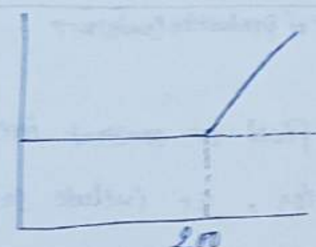
(b) <u>variable cost ($V = v.x$)</u> ⇒ This cost increases directly and proportionally with the vol of production and it include directly and proportionally and it include direct material, direct labour and running cost



(c) <u>Semi-variable</u> (electricity bill, Telephone, water supply)



<u>Notations</u>

F = Fixed cost in rupees.

x = No. of unit produced or vol of production.

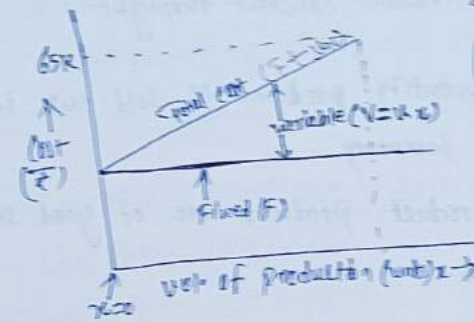
v = variable cost per unit. (₹/unit)

V = Total variable cost in Rupees $\boxed{(v.x)}$

s = selling cost per unit (Rupee/unit)

S = Total Sales or revenue in Rupee $\boxed{(s.x)}$

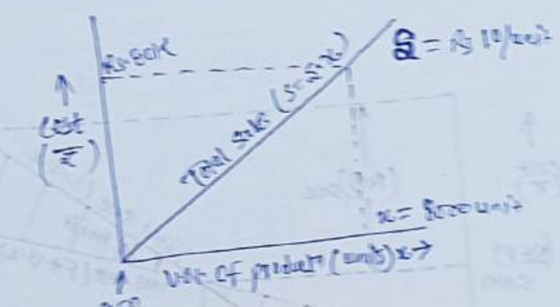
Total Cost ($F + v.x$)



∵ F = Rs 25000
v = Rs 5/unit

$F + v.x$
$25000 + 5 \times 8000$
= Rs 65K

Total Sale ($S = s.x$)



s = Rs 10/unit

It is give the ~~written~~ return obtained by selling out the quantity produced and it is directly proportional to vol of production.

(8)

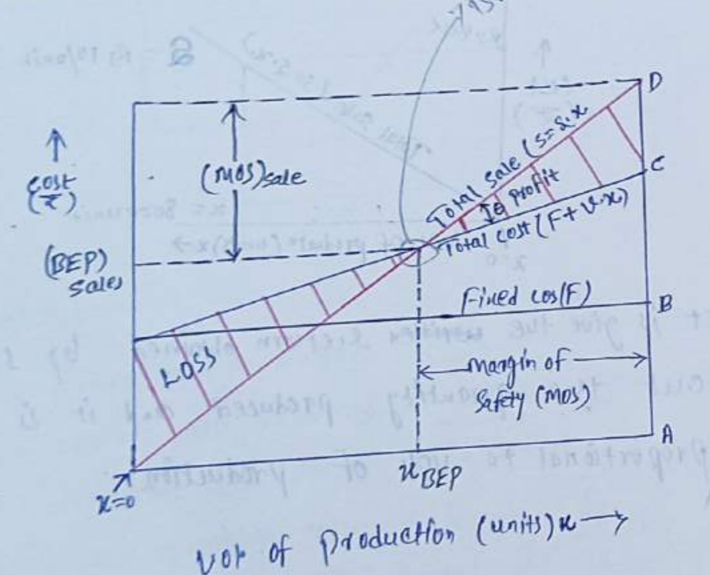
Assumptions in Breakeven chart :-

(1) F, V, S remain constant throught

(2) All the quantity produced or sold out i.e. there is unsold inventory

(3) All the product produced are of good standered dimensions.

(4) effectiveness and efficiency of production system remain constant throught.



(9)

⇒ Breakeven point is a volume of production ~~when with~~ where total cost = Total sales and organisation neither earns profit nor suffer from loss. It is also known as no profit and no loss point.

Total sale = Total cost + profit

Total sale = $S = s \cdot x$

Total cost = $F + V = F + v \cdot x$

Profit $= P$

$$\boxed{S = F + V + P}$$

or

$$\boxed{s \cdot x = F + v \cdot x + P}$$

or

$$(s - v) \cdot x = F + P$$

$$\boxed{x = \frac{F + P}{(s - v)}}$$

$(S \cdot x = s x)$

At BEP, $P = 0$

$$\boxed{x_{BEP} = \frac{F}{(s - v)}}$$ (unit) $\frac{Rs}{Rs/unit}$

★ $$\boxed{(BEP)_{sale} = x_{BEP} \cdot s = \frac{F}{(s - v)} \cdot s}$$ ₹

Terms in Break even chart :-

① <u>Angle of Incidence (θ)</u> :- It is the angle at which total sales line cut the total cost line. Larger this angle better will be the working condition.

② <u>contribution margin</u>

$$\boxed{CM = S - V = (s - v) \cdot x}$$

$$\boxed{\text{Contribution} = (s - v)}$$

$\because$ F = Rs 20,000
v = Rs 6/unit
s = Rs 10/unit
s − v = Rs 4/unit

$S = F + V + P$

$S - V = F + P$

$$\boxed{CM = F + P = (s - v) \cdot x}$$

$$\boxed{P = CM - F}$$

(in page No. 4) Book made easy.

→ marginal profit
or
Gross margin

profit volume graph

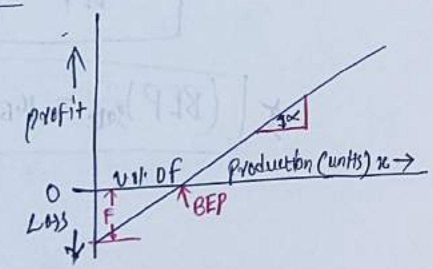
$$\boxed{S = F + V + P}$$

$s \cdot x = F + v \cdot x + P$

$$\boxed{P = (s - v) x - F}$$

① At $x = 0$. $\boxed{P = -F}$

② At BEP ... = F ...



(Profit → volume) ratio

It is the term used to represent profitability related to sales. This ratio always remains constant for a particular product and it is ratio of contribution margin to the vol. of Sales. It is normally preferred when the organisation deal in multiproduct.

$$\left(\frac{P}{V}\right)_{Ratio} = \frac{CM}{S} = \frac{S - V}{S} = \frac{s - v}{s}$$

$$\boxed{\left(\frac{P}{V}\right)_{Ratio} = \frac{F + P\uparrow}{S\uparrow} = \frac{s - v}{s}}$$

Exact
$$\boxed{\frac{F + P_1}{S_1} = \frac{F + P_2}{S_2} = \frac{F}{S_{BEP}} = \frac{s - v}{s}}$$

Approximate
$$\boxed{(P/V)_{Ratio} = \frac{\Delta P}{\Delta S}}$$

<u>NOTES</u> :- • If there is option of increasing the sale, highest (P/V) ratio should be prefferred. and if there is option of decreasing the sales, lowest (P/V) ratio should be preferred.

margin of safety (MOS)

It is the difference of output at full capacity compare to output at break even point.

$$(MOS)_{sale} = (Sale)_x - (Sales)_{BEP}$$

$$\boxed{(MOS)_{sale} = S_x - S_{BEP}} ₹$$

or

$$(MOS)_{sale} = S \cdot x - S \cdot (x)_{BEP}$$

$$= S \cdot \left[x - \frac{F}{(S-V)}\right]$$

$$= S \cdot \left[\frac{(S-V)x - F}{(S-V)}\right]$$

$$= \frac{P}{\left(\frac{S-V}{S}\right)}$$

$$\boxed{(MOS)_{sale} = \frac{P}{(P/V)_{Ratio}}}$$

$$\boxed{MOS\,\% = \left(\frac{S_x - S_{BEP}}{S_x}\right) \times 100}$$

NOTE:- Changes in breakeven point when:-

(1) Fixed cost increases

$F\uparrow \rightarrow x_{BEP}\uparrow$ $\boxed{x_{BEP} = \frac{F}{(S-V)}}$

(2) $V\uparrow \rightarrow x_{BEP}\uparrow$

(3) $S\uparrow \rightarrow x_{BEP}\downarrow$

Q. A product can be produced by four process as given below:- In order to produce 100 unit which process should be preferred?

Medi-zone youtube channel पर है explanation Lecture 2, 25 min

Process	F(₹)	V(₹/unit)	
I	20	3	→ 320
II	40	1	→ 140 Ans minimum or least expenditure
III	30	2	→ 230
IV	10	4	→ 410

$\Rightarrow TC = F + V \cdot x \Rightarrow 20 + 3 \times 100$
$\Rightarrow 320$ ... similarily

$x = 100$

Q. a company requires a product for which they've three options as given below. Draw the total cost graph for all the three process and find the economic fissibility. If 5 thousands units are to be produced, which process should be preffered and the corresponding cost

Options	F (₹)	v (₹/unit)
Purchase (P)	—	10
Semi Automatic (S)	6800	6
Automatic (A)	40400	3

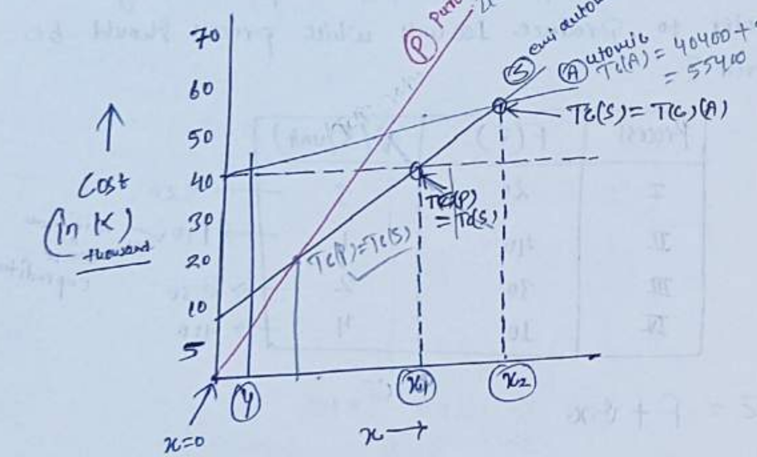
⇒

(P) Purchase ⇒ $TC(P) = 0 + 5000 \times 10 = 50000$

ज़्यादा नहीं है क्यों draw किए ?

(S) emi automatic $TC(S) = 6800 + 6 \times 5000 = 36800$

(A) utomatic $TC(A) = 40400 + 5000 \times 3 = 55400$



$TC(P) = 10 \cdot x$

$TC(S) = 6800 + 6 \cdot x$ ($F + v \cdot x$)

$TC(A) = 40400 + 3 \cdot x$

$x_1 = 1700$, $x_2 = 11200$ unit

$x = 5000$ unit

$TC(P) = Rs\ 50000$

$TC(S) = Rs\ 36800$ ✓ Ans ATQ

$TC(A) = Rs\ 55400$

Q. Find out the Breakeven Sales in rupees for the following product

	Product A	Product B	Product C
Sales (units) (x)	5000	6000	4000
s (Rs/unit)	10	15	18
v (Rs/unit)	6	4	13
Fixed cost of the Product is Rs 20,000			
⇒ $S = s \cdot x$	50K	90K	72K
$V = v \cdot x$	30K	24K	52K

Total sales ← S; selling cost per unit ↑ s; x → vol. of prod.

Total variable cost ← V

⇒ 212K

⇒ 106

$$(P/V)_{Ratio} = \frac{S - V}{S} = \frac{212 - 106}{212}$$

$$(P/V)_{Ratio} = 0.5$$

$$(P/V)_{Ratio} = \frac{F + P}{S} = \frac{F}{S_{BEP}}$$

P → 0 (zero) for Break even

$$0.5 = \frac{20,000}{S_{BEP}}$$

$$S_{BEP} = Rs\ 40,000$$ ✓ Ans

Q. A component can be manufactured in either of two machines operating w/c and operating are given Below. Determine Break even quantity for production of component

PTO

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	1st m/c	2nd m/c
No. of units Produced/hr	15	60
Cost of tooling	Rs 200	Rs 420
Setting time	70 min	230 min
machining Labour/hr	Rs 4/hr	Rs 4/hr
Setting Labour/hr	Rs 15/hr	Rs 20/hr
Overhead Charges	3 times of total Labour Cost	10 time total Labour cost

$\Rightarrow$ TC = Tooling cost + m/c setting cost + machining cost + overhead cost

For

$$TC - (I)^{st}_{machine} = 200 + \left(\frac{70}{60}\right) \times 15 + \left(\frac{x}{15}\right) \times 4 + 3\left[\left(\frac{70}{60}\right) \times 15 + \frac{4x}{15}\right] \quad (1)$$

For

$$TC - II^{nd}_{machine} = 420 + \left(\frac{230}{60}\right) \times 20 + \left(\frac{x}{60}\right) \times 4 + 10\left[\left(\frac{230}{60}\right) \times 20 + \frac{4x}{60}\right] \quad (2)$$

$$TC - I = TC - II$$

$$20 + \left(\frac{70}{60}\right) \times 15 + \left(\frac{4x}{15}\right) + 3\left[\left(\frac{70}{60}\right)15 + \frac{4x}{15}\right] = 420 + \left(\frac{230}{60}\right) \times 20 + \frac{4x}{60} + 10\left[\frac{230}{60} \times 20 + \frac{4x}{60}\right]$$

$x = 2980$ units.

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Q. For a production system

Fixed cost (F) = Rs 10 Lakh
v = Rs 60/unit
s = Rs 100/unit

Due to inflation fixed cost increases by 5% and variable cost (v) increases by 10%. Find the % change required in selling price per unit then BEP unit wise increases by 50%.

$\Rightarrow$ F = Rs 10 Lakh $\Rightarrow$ $F' = 10.5$ Lakh
v = Rs 60/unit $\quad v'$ = Rs 66/unit
s = Rs 100/unit $\quad s' = ?$

50% BEP increased by

$$(x_{BEP})_{New} = 1.5 \times (x_{BEP})_{old}$$

$$\frac{F'}{s' - v'} = 1.5 \times \frac{F}{s - v}$$

$$\frac{10.5}{s' - 66} = 1.5 \times \frac{10}{100 - 60}$$

$$s' = \text{Rs } 94/\text{unit}$$

$$\left(\frac{s' - s}{s}\right) \times 100 = -6\% \downarrow$$

|| INVENTORY ||

INVENTORY can be termed as stock on hand at a given point of time which may be helped for the purpose of later use or sale. It is ideal resource having economic value and it may include raw material, working process inventory, semi-finished or sub-assembly inventory and final product.

In an inventory control our aim is to manage inventory in such a manner that day to day working ~~with~~ run smoothly without any delay. But at the minimum of cost.

Inventory cost
- Purchase cost
- Ordering or Setup cost
- Holding or Carrying cost
- Shortage or Stockout cost

Purchasing cost → It is a cost of purchasing inventory item and it depend upon the qty or the bulk amount purchased.

$$\boxed{P.C = \text{No of units} \times \text{cost/unit}}$$

Ordering cost :- When inventories purchased from outside, the cost associated with bringing inventory within the production system is termed as ordering cost. It include cost of tender, paper work cost, processing fee, communication cost, salary of purchasing department, transportation cost, inspection cost etc.

$$\boxed{O.C = \text{No. of order} \times \text{cost/order}}$$

Setup cost :- When inventory is produced internally the cost associated with brinking ~~stt~~ shutdown production system again into starting position is termed as setup cost it include maintainance cost of machine, schedule chart prepration cost, cost of bringing raw material, arrangement of worker, tool, equipment etc.

$$\boxed{S.C = \text{No of setup} \times \text{cost/setup}}$$

Holding or Carrying cost :- It is a cost associated with storing, keeping and maintaining inventory within the prodn system, It include storage cost handling cost damage and depreciatn cost, insaurance cost, interest etc.

(20)

This cost depend upon the qty and period for which inventory is stored.

$$\boxed{H.C = \text{Average Inventory} \times \text{holding cost/unit/time for a period}}$$

Shortage or Stockout Cost :- Shortage simply mean a Absence of inventory and the loss associated with not serving the customer is termed as shortage or Stockout cost it include potential profit loss (PPL), Goodwill (प्रतिष्ठा, साख) loss, loss of production time, fast transportation cost descount etc.

$$\boxed{S.C = \text{Average no. of units short} \times \text{shortage cost/unit/time}}$$

INVENTORY Classification

1) **Transit or pipeline** :- Inventory can not provide service while in transportation and such inventories called transit or pipeline inventory.

Pto

(2) **Buffer or Safety Stock** :- It is reserve stock kept throughout the year and it's held for protecting against fluctuation in the demand rate and lead time. It is never required under normal working condition and used only during adverse condition to prevent stockout

Lead time - It is a time gap b/w placing an order and inventory on hand, so that it can be used or consumed

Seasonal inventory

The demand for these inventory item changes with seasonal variation.

Anticipation Inventory

These inventory are buildup to meet anticipated demand in future like big selling forecast, Govt. policy change, price hike, strike, shutdown etc.

Decoupling Inventory

It is extra surplus semi finished inventory kept b/w interdependent work station which works as buffer stock during breakdown and maintainence.

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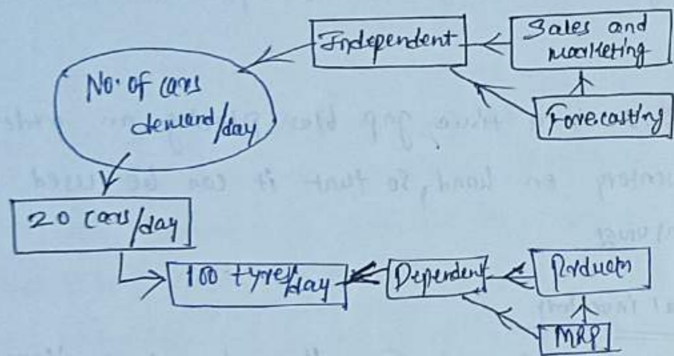
Q2 Inventory model characteristics:-

① Dependent and indipendent demand item

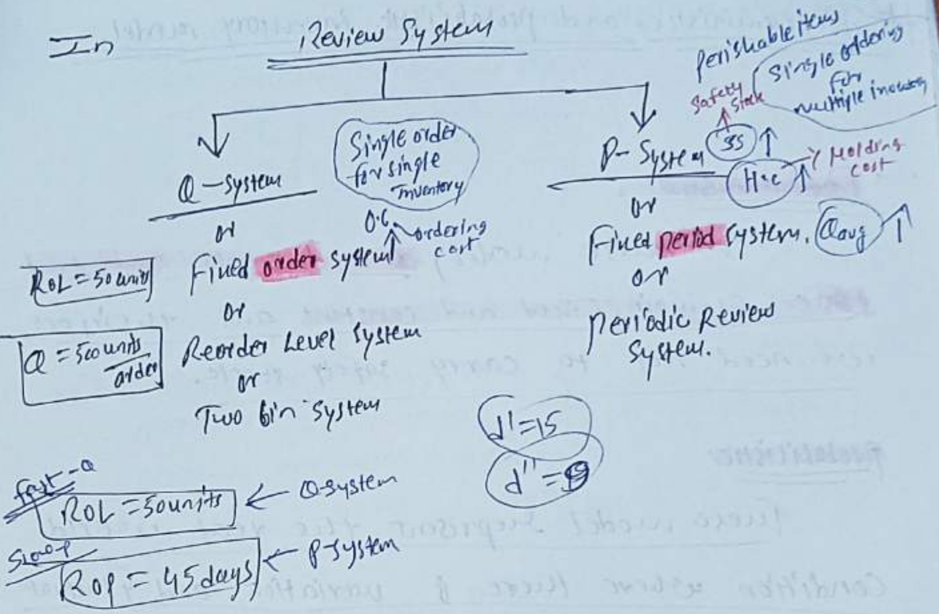


Deppendent

The demand for these items is directly related or linked to any other item, usually of a higher level of which it becomes a part.

Independent

The demand for these items is not directly related or linked to any other item, It is difficult to compute and is projected with the help of forecasting



Fixed order system

In this system as inventory decreases to re-order level, a fresh order for fixed qty is placed at that point. In this system size of order is fixed but, the time of order is variable.

Fixed period system:- In this system inventory is reviewed after a fix period of time and a fresh order for variable qty is placed at that point. In this system size of order is variable but the time of order is fixed.

Deterministic and probabilistic inventory model.

Deterministic

In these model, demand rate and lead time remain fixed and constant and therefore we need not to carry safety stock.

Probabilistic

These model represent the real world condition where there is variation and fluctuation in the demand rate and lead time in these model we need to carry safety stock to prevent stock out during adverse condition.

Notation

D – Annual or yearly demand of inventory (units/year)

Q → Qty to be ordered at each order point (units/order) or (current ordering policy)

N → No of order placed in a year (order/year)

$\boxed{N = \frac{D}{Q}}$

$N = \frac{(D = 48000 \text{ units/yr})}{(Q = 8000 \text{ units/order})} = 6 \text{ order/yr}$

T = Time length of one inventory cycle or time gap b/w two successive order. (yr/order)

$\boxed{T = \frac{1}{N}}$ or $\boxed{T \cdot N = 1}$

or

$\boxed{T = \frac{Q}{D}}$

∵ They should be in similar unit

N = 4 order/yr

T = 3 month/order

$T = \frac{3 \times 4}{4}$ month/order

$\boxed{T = \frac{1}{4} \text{ yr/order}}$

d = Demand or consumption rate or no. of units consumed per unit time.

(units/day, units/week, units/month)

If yearly demand $\boxed{D = d}$

C = Cost of purchasing one unit of inventory (₹/unit)

C_o = Cost of placing one order. (₹/order)

C_h = Holding rate or cost of holding one unit in inventory for 1 complete year. (₹/unit/yr)

Economic order qty (EOQ)

or

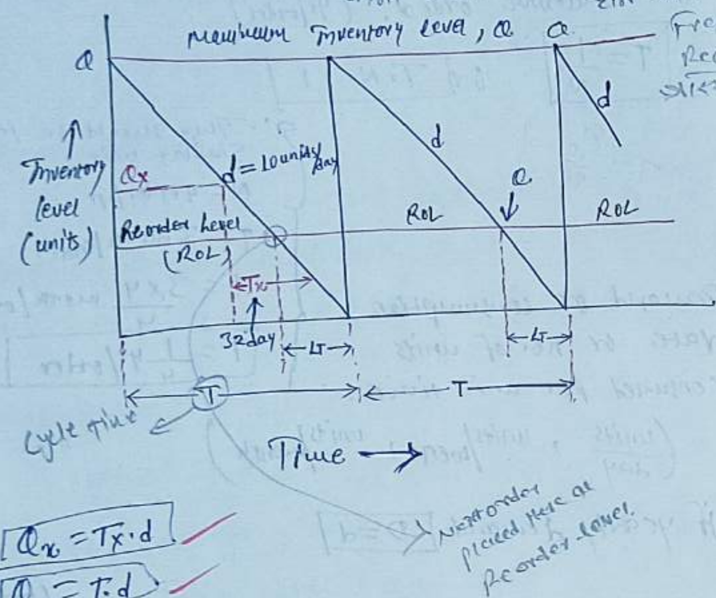
Harris wilson model

or

Infinite rate of Replenishment

→ Ist Model

यहाँ (EOQ model) में हमारी inventory कभी खतम नहीं होगी, जैसे ही खतम होने वाली होगी Fresh order Receive हो, आएगा



$\boxed{Q_x = T_x \cdot d}$

$\boxed{Q = T \cdot d}$

$\boxed{ROL = LT \cdot d}$

$$\boxed{d = \frac{Q}{T} = \frac{Q_x}{T_x} = \frac{ROL}{LT}}$$

Total annual cost (TAC or TC)

Total annual cost (TAC or TC) = Purchase cost (P.C) + ordering cost (O.C) + Holding cost (H.C)

$\boxed{P.C = D \times C}$

$\boxed{O.C = N \times C_o}$

$\boxed{O.C = \frac{D}{Q} \cdot C_o}$

40, 30, 20, 10, 0	$Q_{avg} = \frac{100}{5} = 20$ units	$Q_{avg} = \frac{40+0}{2} = 20$
C_h = Rs 2/unit/day	$H.C = 20 \times 5 \times 2$	or
H.C = Rs 200	H.C = Rs 200	H.C for period T $= \frac{Q}{2} \cdot T \cdot C_h$

Annual $H.C = \frac{Q}{2} \cdot C_h \cdot (T \cdot N) \to 1$

$$\boxed{H.C = \frac{Q}{2} \cdot C_h}$$

$$\boxed{TAC = D.C + \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h}$$

Constant

Total inventory cost or Total variable cost = O.C + H.C

$$TIC = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h$$

$$\boxed{TAC \text{ or } TC = TIC + D.C}$$

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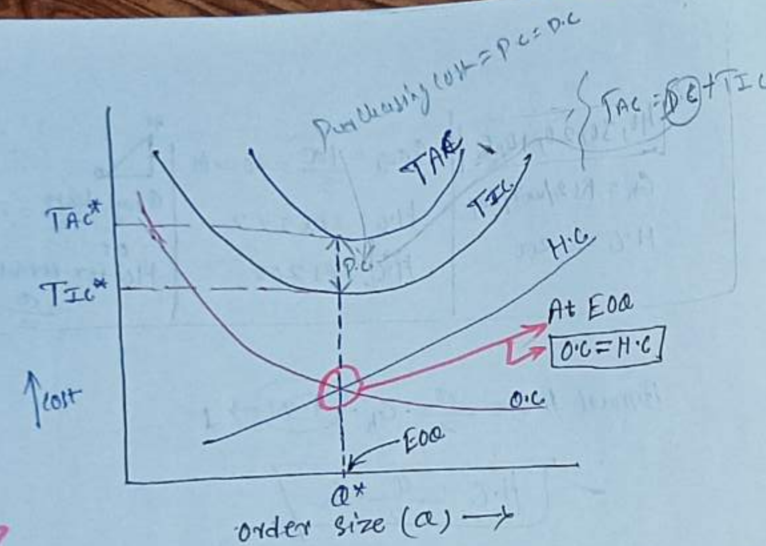

EOQ

The ordering qty (Q^*) at which holding cost become equals to ordering cost and total inventory cost is minimum is known as economic order ~~qty~~ qty.

$*$ → star represents that we are talking about EOQ

At EOQ

$\boxed{O.C = H.C}$

$$\boxed{\frac{D}{Q^*} \cdot C_o = \frac{Q^*}{2} \cdot C_h} \quad \text{— (1)}$$

$$Q^* = \sqrt{\frac{2D \cdot C_o}{C_h}}$$

$$\boxed{TIC^* = \frac{D}{Q^*} \cdot C_o + \frac{Q^*}{2} \cdot C_h} \quad \text{— (2)}$$

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$TIC^* = 2 \cdot \frac{Q^*}{2} \cdot C_h$ — from (1) and (2)

$$\boxed{TIC^* = 2 \times H.C = 2 \times O.C}$$

$$TIC^* = Q^* \cdot C_h$$

$$\frac{\sqrt{2DC_o}}{\sqrt{C_h}} \times \sqrt{C_h} \times \sqrt{C_h}$$

$\star\star\star$ $\boxed{TIC^* = \sqrt{2DC_oC_h}}$ ← only for EOQ

$\boxed{TIC(Q) = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h}$ ← for EOQ or Non-EOQ

For TIC to be minimum $\frac{d(TIC)}{d(Q)} = 0$,

$$\frac{C_h}{2} - \frac{D \cdot C_o}{Q^{*2}} = 0$$

$$\boxed{Q^* = \sqrt{\frac{2DC_o}{C_h}}}$$

2nd diff.

$$0 - (-2) \cdot \frac{D \cdot C_o}{Q^{*3}}$$

$$+ \frac{2 \cdot D \cdot C_o}{Q^{*3}}$$

NOTE → when holding cost is given in terms of interest or % it always correspond to unit price of Inventory and interest ~~rate~~ rate should be always year.

$\boxed{\text{e.g. } C_h = \% \text{ of } C}$ → yearly

$C = \text{Rs } 60/\text{unit}$

$I\% = 1\%/\text{month}$

$I\% = 12\%/\text{year}$

$C_h = 0.12 \times 60 = \text{Rs } 7.2/\text{unit/yr.}$

Q. Maximum inventory level is $\underset{3000 \text{ unit}}{\overset{Q}{\downarrow}}$ and it is achieved with infinite rate of replenishment, Inventory become zero in $1\frac{1}{2}$ month, due to consumption at uniform rate $C_o = Rs\ 1600/\text{order}$, C_h is Rs. 2.5/unit/month then determin,

(i) Total inventory cost neglecting purchasing cost

(ii) Design a better ordering plan and find out the saving possible

⇒ $Q = 3000$ unit/order

$T = 1.5$ month/order $\rightarrow$ 12 month in a year

$N = \frac{12}{1.5} = 8$ order/year $\left\{ \because N = \frac{D}{Q} \right\}$ or $\left\{ N = \frac{1}{T} \right\}$

$N = \frac{D}{Q} \Rightarrow D = 24000$ unit/yr

$C_o = Rs\ 1600/\text{order}$

$C_h = Rs\ 2.5/\text{unit/month}$

$\downarrow \times 12$

$C_h = Rs\ 30/\text{unit/yr}$

(1) $TIC = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h$

$= 8 \times 1600 + \frac{3000}{2} \times 30$

$\Rightarrow Rs.\ 57800$

(2) $Q^* = \sqrt{\frac{2DC_o}{C_h}} = \sqrt{\frac{2 \times 24000 \times 1600}{30}}$

$Q^* = 1600$ unit/order

$TIC^* = \sqrt{2DC_oC_h}$

$= Q^* \cdot C_h$

$= Rs\ 48000$

Saving $= 57800 - 48000$

$\therefore = Rs\ 9800$

V. Nice Que

Q. ** Total inventory cost at order size of 400 units and 1600 unit are equal then determine EOQ that is Q^*?

⇒ Total inventor cost $TIC(Q) = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h$

$TIC(400) = TIC(1600)$

$\frac{D}{400} \cdot C_o + \frac{400}{2} \cdot C_h = \frac{D}{1600} \cdot C_o + \frac{1600}{2} \cdot C_h$

$D\,C_o \left[\frac{1}{400} - \frac{1}{1600} \right] = C_h \, (800 - 200)$

$\frac{D \cdot C_o \times 1200}{400 \times 1600} = C_h \times 600$

$\frac{2 \cdot D \cdot C_o}{C_h} = 400 \times 1600$

$Q^* = \sqrt{\frac{2DC_o}{C_h}} = \sqrt{400 \times 1600}$

$Q^* = 800$

$TIC(Q_1) = TIC(Q_2)$

Then $Q^* = \sqrt{Q_1 \cdot Q_2}$

V. Nice Que

Q The demand of sugar at a retailer is 40kg/day. And he purchase it @Rs50/kg. Retailer spend Rs 200 for each order and the holding rate is Rs. 0.1/kg/day. Lead time is of 3 days the retailer current ordering policy is to order 200kg every 5 day then determine

(i) EOQ (ii) Amount of saving with EOQ compared to current policy in 30 days.

(2)

$\Rightarrow$ $d = 40\,kg/day$

$C = ₹\ 50/kg$

$C_o = ₹\ 200/order$

$C_h = ₹\ 0.1/kg/day$

$LT = 3\,day$

$\boxed{Q = 200\,kg/order}$

{∵ D=d if year demand}

(i) $\boxed{Q^* = \sqrt{\frac{2DC}{C_h}}}$ → should be in similar unit always.

$= \sqrt{\frac{2 \times 40 \times 200}{0.1}}$

$Q^* = 400\,kg/order$

(2) 30 days

$D = 30 \times 40 = 1200\,kg/month$

$C_h = 30 \times 0.1 = Rs\ 3/kg/month$

(a) $Q = 200\,kg/order$

$TIC = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h$

$= \frac{1200}{200} \times 200 + \frac{200}{2} \times 3$

$= Rs\ 1500$

(b) $Q^* = 400\,kg/order$

$TIC^* = \frac{1200}{400} \times 200 + \frac{400}{2} \times 3$

$TIC^* = Rs\ 1200$, $\boxed{Saving = Rs\ 300}$ Ans

★★★

Q. Determine value of EOQ when annual demand is worth Rs. 50000, C_o is 4% of order value and C_h is 10% of avg. Inventory value.

$\Rightarrow$ $D \cdot C = Rs.\ 50{,}000$

$C_o = 4\% \, (Q^* \cdot C)$ → order/day, cost

$C_h = 10\%$ of C → can only applied in order purchasing cost

$Q^* = \sqrt{\frac{2DC_o}{C_h}}$

$Q^* = \sqrt{\frac{2 \times 50{,}000 \times 0.04 \times Q^* \cdot C}{C \times 0.1 \times C}}$ → 100 C why?

$Q^* = \frac{40{,}000 \times Q^*}{C}$

$\boxed{Q^* \cdot C = Rs.\ 40{,}000}$ Ans

Q. In a production system

Best case to learn basic

$D = 18000\ units/yr$

$C = Rs\ 8/unit$

$C_o = Rs\ 240/order$

part of C_h ✓ Interest = 5%

✓ Damage = 2%

Transportation = 3%

part of C_h ✓ Storage = 5%, $LT = 60\ days$

300 working days/yr

→ C_h = Interest + Damage + Sto = 5% + 2% + 5% = 12%

$C_h = 0.96/unit/yr$ → $\frac{8 \times 12}{100}$ → $\frac{8 \times 12}{100} = 0.96$

Then ~~determine~~

(54) Then determine

NOTE:- RoL always will equal to Q or less than Q*

(i) Q^*

(II) optimum no. of orders in a year

(III) optimum length of 1 inventory cycle

(IV) TIC star

(V) RoL

(VI) No. of days of stock at re-order point

(VII) amount of saving with EOQ against the earlier practice of 4 orders in a year.

(VIII) increase in total cost associated with ordering

(a) 25% more than EOQ

(b) 25% less than EOQ

⇒ (1) $Q^* = 3000$ unit/order $\rightarrow \sqrt{\frac{2 \times 18000 \times 240}{0.96}}$ → How

(2) $N^* = \frac{D}{Q^*} = 6$ order/yr $\rightarrow \frac{18000}{3000} = 6$

(3) $T^* = \frac{1}{N^*} = \frac{1}{6}$ yr/order ⇒ $T^* = 50$ days/order

→ Given in que 300 working day/yr

So, $\frac{300}{6} = 50$ day/order

(4) $TIC^* = \sqrt{2DC_oC_h}$

$= Rs\ 2880$

(5) $RoL = LT \times d$

$$\boxed{d = \frac{18000}{300},\quad d = 60 \text{ units/day}} \rightarrow d = \frac{Q}{T}$$

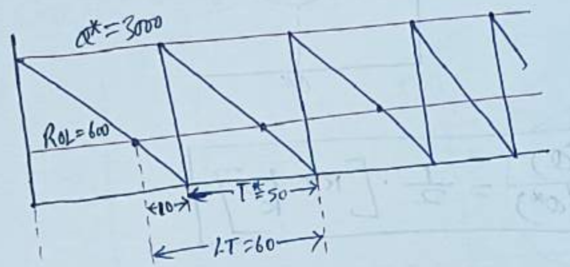
$RoL = 60 \times 60$

$RoL = 3600$ unit ✗ This is wrong should not more than Q^*

Effective $LT = 60 - 50$

$= 10$ day

$RoL = 10 \times 60 = 600$ units



(6) 10 days

(7) $N = 4$ order/yr, $Q = 4500$ units/order → $N = \frac{D}{Q} = 4$

$N = \frac{D}{Q}$, $Q = \frac{D}{N}$, $Q = \frac{18000}{4}$

$TIC = 4 \times 240 + \frac{4500}{2} \times 0.96 = Rs.\ 3120$

$Saving = 3120 - 2880 = Rs.\ 240$

(8) a) 25% more than Q^*

$Q = 125 \times 3000 = 3750$ unit/order

$TIC = \frac{18000}{3750} \times 240 + \frac{3750}{2} \times 0.96$

$= Rs\ 2952$

Increase $= 2952 - 2880 = Rs\ 72$ ↑

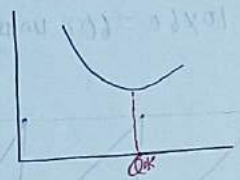
(56)

(b) 25% less than Q^*

$Q = 0.75 \times 3000 = 2250$ units/order

$TIC = Rs\ 3000$

Increase $= Rs\ 120 \uparrow$



$$\boxed{\frac{TIC(Q)}{TIC(Q^*)} = \frac{1}{2} \cdot \left[K + \frac{1}{K}\right]}$$

$\boxed{Q = K \cdot Q^*}$

model sensitivity
or
model Robustness

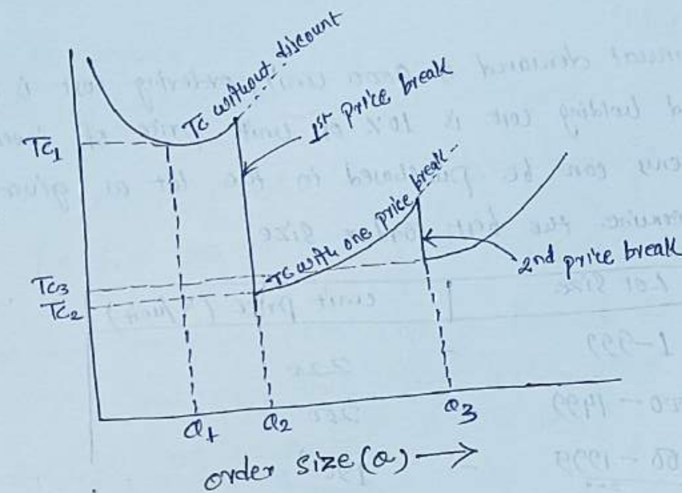
$$\frac{TIC}{2880} = \frac{1}{2}\left[1.25 + \frac{1}{1.25}\right]$$

$TIC = 2952$

(57)

17-03-21

2nd model with EOQ with price break
or
Quantity discount



$$\boxed{TC = D \cdot C + \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h}$$

In some condition discount is offered on unit price of inventory for large qty purchase and there discount take the form of price break. As discount is always offered on unit price of inventory, in order to determine the best order qty we need to consider purchasing cost along with ordering and holding cost. In these problem 1st we compute

(8)

Feasible EOQ and then total cost is computed at EOQ and the next higher order size having price break, wherever the total cost comes out to be minimum give the best order size

WB 25 (P-64)

Q. annual demand is 8000 unit, ordering cost is Rs 1800/order and holding cost is 10% of unit price of inventory. Items can be purchased in the lot as given below determine the best order size.

	Lot size		unit price (₹/unit)
1	1-999	–	220
2	1000 – 1499 EOQ	–	200
3	1500 – 1999 2nd	–	190 1st Break point after EOQ
4	2000 and above	–	185 2nd price Break point

We know that

$$EOQ \text{ i.e } Q^* = \sqrt{\frac{2DC_o}{C_h}}$$

where $C_h = 10\%$ of C

इसकी last से start करके feasibility check करेंगे

checking feasibility (4) $C_h =$ ~~10% of C~~ $\Rightarrow$ Rs 185/unit

$$Q^* = \sqrt{\frac{2 \times 8000 \times 1800}{(185 \times 0.1)}} = \underset{1st}{1247.7} \text{ unit/order}$$

It is not feasible as for C = Rs 185/unit

$Q \geq 2000 \Rightarrow$ [must be greater than 2000 की]

(39)

(3) C = Rs 190/unit

$$Q^* = \sqrt{\frac{2 \times 8000 \times 1800}{(190 \times 0.1)}} = \underset{2nd}{1231.17} \text{ unit/order}$$

Again not feasible must be within range 1500-1999

(2) C = Rs 200/unit

$$Q^* = \sqrt{\frac{2 \times 8000 \times 1800}{200 \times 0.1}} = 1200 \text{ units/order}$$

It is feasible as for C = Rs 200/unit, Q must be b/w 1000 to 1499.

Now we compute total cost as feasible EOQ i.e. $Q^* = 1200$ and the next higher price break point of $Q = 1500$ and $Q = 2000$

$$TC(Q) = D \cdot C + \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h$$

$$TC(1200) = 8000 \times 200 + \frac{8000}{1200} \times 1800 + \frac{1200}{2} \times (200 \times 0.1)$$

$$= Rs\ 1624000$$

$$TC(1500) = 8000 \times 190 + \frac{8000}{1500} \times 1800 + \frac{1500}{2} \times (190 \times 0.1)$$

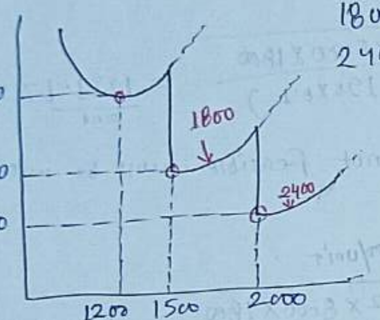
$$= Rs\ 1543850$$

$$TC(2000) = 8000 \times 185 + \frac{8000}{2000} \times 1800 + \frac{2000}{2} \times (185 \times 0.1)$$

$$= Rs\ 1505700 \text{ Ans}$$

So at 2000, cost is minimum then EOQ = 2000 Lot

(40)



1800 → 1545100
2400 → 1508200

Q/ D = 5000 units/yr

C = ₹ 5/unit

C_o = ₹ 80/order

C_h = ₹ 0.8/unit/yr

Discount means we are subtracting something which is with cost. And remaining left we multiply it with cost.

$Q^*(1000) \to TC = Rs\ 25800$

If Q = 2500, 6% discount on C → (5×0.94) 4.7 → Rs 24660 Ans

Q = 5000, 9% discount on C → (5×0.91) 4.55 → Rs 24830 Ans

Determine best order size ?

⇒ we know that EOQ $Q^* = \sqrt{\frac{2DC_o}{C_h}}$

$= \sqrt{\frac{2 \times 5000 \times 80}{0.8}} = 1000$

$TC(Q) = D \cdot C + \frac{D}{Q} C_o + \frac{Q}{2} \cdot C_h$

$TC(1000) = 5000 \times 5 + \frac{5000}{1000} \cdot 80 + \frac{1000}{2} \cdot 0.8 \Rightarrow Rs\ 25800$

$TC(2500) = 5000 \times 4.7 + \frac{5000}{2500} \times 80 + \frac{2500}{2} \times 0.8$

$= 24660$ Ans

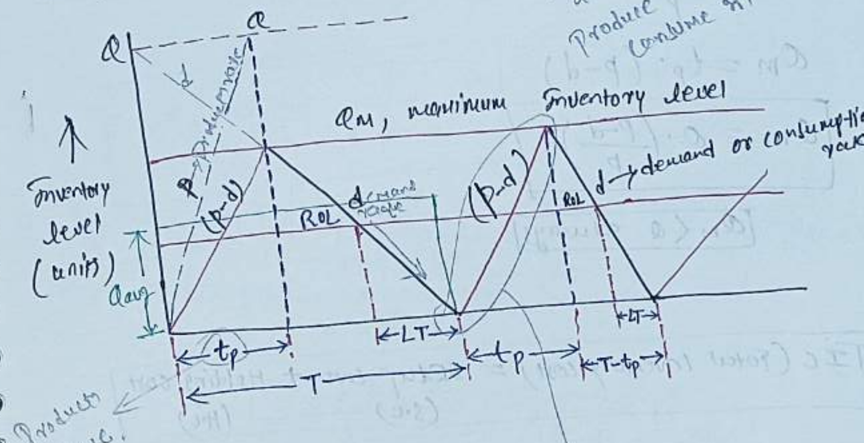
(41) $TC(5000) = 5000 \times 4.55 + \frac{5000}{5000} \times 80 + \frac{5000}{2} \times 0.8$

$TC(5000) = 24830$ Ans

3rd model

Production and buildup model

जहाँ Inventory internally produce करके consume की जाती है।



This model is similar to 1st model EOQ the only difference, the inventory buildup is gradual rather than instantaneous.

Q → Qty to be produced or manufactured in every setup (units/setup)

C_o → Cost of one setup (₹/setup)

t_p → Production or manufacturing time.

(42)

p → production or buildup rate

d → Demand or consumption rate $\quad p > d$ → should be

$$\boxed{Q = T \cdot d}$$

$$\boxed{Q = t_p \cdot p}$$

$$t_p = \frac{Q}{p}$$

$$Q_m = t_p \cdot (p-d)$$

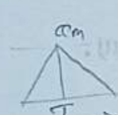
$$\boxed{Q_m = Q \cdot \left(\frac{p-d}{p}\right)}$$

maximum $\boxed{Q_m < Q \text{ always}}$ → Because जैसे-जैसे produce कर रहे हैं तो वैसे वैसे consume भी कर रहे हैं (Time) inventory का buildup होने का नहीं मिल रहा।

$$\boxed{\text{TIC (Total Inventory cost)} = \underset{(S.C)}{\text{setup cost}} + \underset{(H.C)}{\text{Holding cost}}}$$

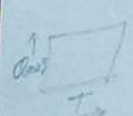
$$S.C = \text{No. of setup} \times \text{cost/setup}$$

$$\boxed{S.C = \frac{D}{Q} \cdot C_o}$$



$$H.C = Q_{avg} \times C_h$$

$$\boxed{\text{Area of Rectang} = \text{Area of triangle}}$$ from Diagram



$$Q_{avg} \times T = \frac{1}{2} \times T \times Q_m$$

$$Q_{avg} = \frac{Q_m}{2}$$

$$Q_{avg} = \frac{Q}{2} \cdot \left(\frac{p-d}{p}\right)$$

$$\boxed{H.C = \frac{Q}{2} \cdot C_h \left(\frac{p-d}{p}\right)}$$

Total Inventory cost (TIC) = $\frac{\ldots}{Q} C_o + \ldots 2 \ldots (p \ldots)$

For TIC to be minimum

$$\frac{dTIC}{dQ} = 0,$$

$$\frac{C_h}{2}\left(\frac{p-d}{p}\right) - \frac{D}{Q^{*2}} \cdot C_o = 0$$

$$Q^* = \sqrt{\frac{2DC_o}{C_h} \cdot \left(\frac{p}{p-d}\right)}$$

$$\boxed{Q^* = \frac{2DC_o}{C_h} \cdot \sqrt{\frac{p}{p-d}}}$$ ← Production Factor > 1

$$p \to \infty \qquad \sqrt{\frac{1}{1-\frac{d}{p}}} \quad \frac{d}{p} \to 0, \; p \to \infty$$

At EOQ

$$\boxed{S.C = H.C}$$

$$\boxed{TIC^* = \sqrt{2DC_oC_h} \sqrt{\frac{p-d}{p}}}$$ ← (< 1)

Q. A company require 12000 (D) units in a year and It is produced in 40 (N) batches (or setup) of 300 (Q) units each on a m/c that produces 8 units/hr (p). The company operate for 4000 hr/yr. C_o = Rs 500/setup and C_h = Rs 15/unit/yr. Find out wether the existing production plan is optimum and if not, design a better ordering plan and find the ~~Area~~ Amount of saving possible. Also determin prodn time, maxm inventry level.

(Q4) and total cycle time corresponding to optimum condition

$\Rightarrow$ $D = 12000$ units/yr

$\boxed{N = 40,\ Q = 300}$

$p = 8$ units/hr

4000 hrs/yr

C_o = Rs 500/setup

C_h = Rs 15/unit/yr

$d = \frac{12000}{4000} = 3$ units/hr

$d = \frac{D}{T}$

(1) $Q^* = \sqrt{\frac{2DC_o}{C_h} \cdot \left(\frac{p}{p-d}\right)} = 1131.37$ units/setup

$TIC^* = \sqrt{2DC_o \cdot C_h \cdot \left(\frac{p-d}{p}\right)} \Rightarrow \sqrt{2 \times 12000 \times 500 \times 15 \left(\frac{8-3}{8}\right)}$

= Rs 10606.6 → should not be in fraction & the setup को Tod दर

$\boxed{N^* = \frac{D}{Q^*}} = \frac{12000}{1131.37} = 10.6$ setup/yr

1st highest side above 10.6 $N = 11,\ Q = \frac{12000}{11} = 1090.9$ × should not be in fraction

(a) $N = 12,\ Q = \frac{12000}{12} = 1000$ ✓

Now below 10.6 (b) $N = 10,\ Q = \frac{12000}{10} = 1200$

PTO

Now $TIC(Q) = \frac{D}{Q} \cdot C_o + \frac{Q}{2} \cdot C_h \cdot \left(\frac{p-d}{p}\right)$

(a) $N = 12,\ Q = 1000$ ∵ $TIC(1000) = \frac{12000}{1000} 500$

TIC = Rs. 10687.5

(b) $N = 10,\ Q = 1200$

TIC = Rs. 10625 कम पैसा में आएगा unit

Now Current policy is

$N = 40,\quad Q = 300$

$TIC = 40 \times 500 + \frac{300}{2} \times 15 \times \left(\frac{5}{8}\right)$

TIC = Rs 21406.25

Saving = 21406.25 − 10625 ⇒ 10781.25 Ans 1

-Now production time $t_p = \frac{Q}{p} = \frac{1200}{8} = 150$ hrs/setup

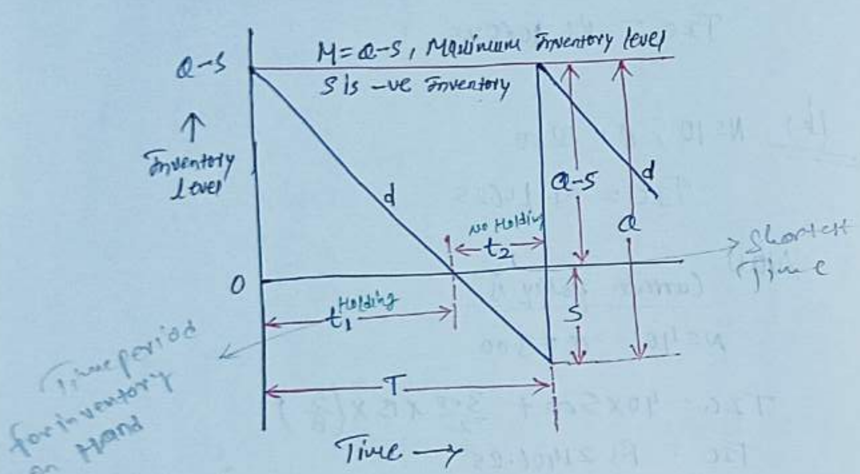
$Q_m = t_p \cdot (p-d) = 150 \times 5 = 750$ units/setup Ans 3

$\boxed{T = \frac{Q}{d} = \frac{1200}{3} = 400 \text{ hrs/setup}}$ Ans 2

PTO

4th model

Shortage or Stockout or Backorder model



This model is similar to 1st model EOQ the only difference shortages are allowed. Planned shortage or Backorder is the condition when a customer places an order and finds that inventory is out of stock then he wait for the next shipment ~~then~~ to get his order fullfilled

$S \rightarrow$ no. of units short of back order

$C_b \rightarrow$ Backorder or shortage cost per unit back ordered per year (₹/unit/year)

$C_h \rightarrow$ (₹/unit/yr)

$TIC = O.C + H.C +$ Shortage cost (S.C)

Annually, ordering cost: $\boxed{O.C = \frac{D}{Q} \cdot C_o}$

Annually, Holding cost: $\boxed{H.C = \frac{(Q-S)^2}{2Q} \cdot C_h}$

Shortage cost: $\boxed{S.C = \frac{S^2}{2Q} \cdot C_b}$

H.C for period T

Avg Inventory, time, rate

$\Rightarrow \left(\frac{Q-S}{2}\right) \cdot t_1 \cdot C_h$

$(Q-S) = t_1 \cdot d$

$Q = T \cdot d$

On dividing

$\frac{t_1}{T} = \frac{Q-S}{Q}$

$\boxed{t_1 = \left(\frac{Q-S}{Q}\right) \cdot T}$

H.C For period T

$= \left(\frac{Q-S}{2}\right) \cdot \left(\frac{Q-S}{Q}\right) T \cdot C_h$

$= \frac{(Q-S)^2}{2Q} \cdot C_h \cdot T$

$\boxed{\text{Annual H.C} = \frac{(Q-S)^2}{2Q} \cdot C_h \cdot T \cdot N \rightarrow 1}$

$\left\{ \frac{(Q-S)}{2} \frac{(Q-S)}{Q} \right\}$

(48)

S.C for period T

$= \frac{S}{2} \cdot t_2 \cdot C_b$

$S = t_2 \cdot d$

$Q = T \cdot d$

On dividing

$\frac{t_2}{T} = \frac{S}{Q}$

$\boxed{t_2 = \frac{S}{Q} \cdot T}$

Shortage cost S.C for period T

$= \frac{S}{2} \cdot \frac{S}{Q} \cdot T \cdot C_b$

$= \frac{S^2}{2Q} \cdot C_b \cdot T$

$\boxed{\text{Annual S.C} = \frac{S^2}{2Q} \cdot C_b \cdot T \cdot N} \rightarrow 1$

$$\boxed{TIC = \frac{D}{Q} \cdot C_o + \frac{(Q-S)^2}{2Q} C_h + \frac{S^2}{2Q} \cdot C_b}$$

$\downarrow$

$$\boxed{Q^* = \sqrt{\frac{2DC_o}{C_h}} \cdot \sqrt{\frac{C_b + C_h}{C_b}}} \rightarrow \text{cost factor} > 1$$

$C_b \to \infty$ $\sqrt{1 + \frac{C_h}{C_b}}$, $\frac{C_h}{C_b} \to 0$, $C_b \to \infty$

$C_b = \text{Rs } 1000/\text{unit}/\text{yr}$

$C_h = \text{Rs } 2/\text{unit}/\text{yr}$

(49)

At EOQ $\boxed{O.C = H.C + S.C}$

$$\boxed{TIC^* = \sqrt{2DC_oC_h} \cdot \sqrt{\frac{C_b}{C_b + C_h}}} \rightarrow < 1$$

Optimum no. of units ~~backward~~ backordered or Short (S^*)

Q-S: Holding cost on Right side of graph

$$\boxed{(Q^* - S) \times C_h = S^* \times C_b}$$

$C_b \rightarrow$ shortage cost

$$\frac{Q^* - S^*}{S^*} = \frac{C_b}{C_h}$$

Addition +1 both side

$$\boxed{\frac{Q^*}{S^*} = \frac{C_b + C_h}{C_h}}$$

$$\boxed{S^* = Q^* \cdot \frac{C_h}{C_b + C_h}}$$

Maxm inventory level

$M^* = Q^* - S^*$

$$\boxed{M^* = Q^* \cdot \frac{C_b}{C_b + C_h}}$$

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exam में कहीं नहीं आया

Production and Shortage model (p, C_b)

$$\boxed{Q^* = \frac{2DC_o}{C_h} \cdot \sqrt{\frac{p}{p-d}} \cdot \sqrt{\frac{C_b+C_h}{C_b}}}$$

$$\boxed{TIC^* = \sqrt{2DC_oC_h} \cdot \sqrt{\frac{p-d}{p}} \cdot \sqrt{\frac{C_b}{C_b+C_h}}}$$

Case-I $\rightarrow$ $p \rightarrow \infty$, Shortage

Case-II $\rightarrow$ $C_b \rightarrow \infty$, production

Case-III $\rightarrow$ $p \rightarrow \infty$, $C_b \rightarrow \infty$, EOQ.

18/03/21

Q A Dealer supplies the following information $D = 10{,}000$ units/yr, $C = 20$/unit, $C_o =$ Rs 10/order and $C_h = 20\%$ of unit price of inventory.

Dealer is considering the possibility of back ordering and he has estimated that the annual cost of back ordering is 25% of unit price of inventory. then determine.

(i) optimum no. of units back ordered

(II) optimum order quantity

(III) The amount of saving possible by adopting the policy of back ordering

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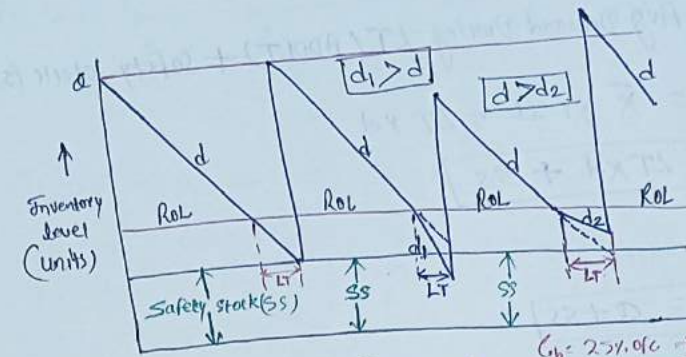

$C_h = 20\%$ of C $= 0.2 \times 20 = 4$ Rs/unit

$C_b = 25\%$ of C $\rightarrow 0.25 \times 20 = 5$ Rs/unit

$C_h =$ Rs 4

$C_b =$ Rs 5

$Q^* = \sqrt{\frac{2 \times 10000 \times 10}{4}} \times \sqrt{\frac{4+5}{5}}$

2) $Q^* = 300$

1) $S^* = 133.33 \rightarrow 300 \times \frac{4}{9}$

$TIC^* = \sqrt{2DC_oC_h}\sqrt{\frac{C_b}{C_b+C_h}}$

$\cancel{\sqrt{2 \times 10000 \times}\sqrt{\frac{5}{5+4}}}$

$TIC^* = \sqrt{2 \times 10000 \times 10 \times 4}\sqrt{\frac{4}{9}} \Rightarrow 596.18$

3) Rs 227.76

$TIC = \frac{D}{Q} \cdot C_o + \frac{(Q-S)^2}{2Q} \cdot C_h + \frac{S^2}{2Q} \cdot C_b$

$= \frac{10000}{300} \times 10 + \frac{(300-133)^2}{2 \times 300} \cdot 4 + \frac{(133.33)^2}{2 \times 300} \times 5 \Rightarrow 367.39$

Saving $= 596.18 - 367.39 = 227.76$ Rs

Factors encouraging higher safety stock :-

(i) when the demand rate and lead time variations are more and fluctuating.

(2) when the inventory holding cost is very less and is not of much concern.

(3) when the loss due to absence of inventory that is shortage cost is very high.

(4) when the no. of orders in a year are more.

(5) To provide better customer satisfaction.

RoL = Avg Demand During LT (ADDLT) + Safety stock (SS)

ADDLT = $\bar{x}$ or μ = LT × d

$\boxed{RoL = LT \times d + SS}$

max^m inventory

$\boxed{Q_{max} = Q + SS}$

$\boxed{Q_{min} = SS}$

$\boxed{Q_{avg} = \frac{Q}{2} + SS}$

$\boxed{Q^* = \sqrt{\frac{2DC_0}{C_h}}}$

(i) Demand profit model or Static inventory model

In this model demand is uncertain and decision is based upon single order. i.e Reordering is not Permitted. This model is used for Perishable items like vegitables, Fruits, Flowers etc, or for those items which become outdated very fast

D – Demand

S – Supply

p – profit/unit

l → loss/unit

(i) If $D_{Demand} > S_{supply}$ → $\boxed{(D-S) \cdot p}$ → Potential profit loss

(500) (500)

(ii) If S > D → $\boxed{(S-D) \cdot l}$ → unsold item loss

500 400

where

$\boxed{p = S_p - C + C_b}$

$\boxed{l = C - C_s + C_h}$

p → PPL/unit for not meeting the demand

S_p → Selling price/unit

C → Purchasing cost/unit

C_b → Back order or shortage cost or goodwill loss/unit

l → unsold item loss/unit due to over supply.

C_s → Salvage or Scrap value/unit or resale value

C_h → holding cost/unit

In this model in order to maximize our profit, we Select ordering qty (S) such that

$$\boxed{P(S-1) < \frac{p}{p+l} \le P(S)}$$

→ cumulative probability of the demand for S unit

cumulative probability of the demand for (S-1) unit

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* If $\boxed{C = S_p = C_s}$

$p = C_b \quad l = C_h$

$$\boxed{P(S-1) < \frac{C_b}{C_b + C_h} \le P(S)}$$

$\frac{p}{p+l} = 0.54$

Demand	Probability	Cumulative prob
1	0.06	0.06
2	0.12	0.18
3	0.09	0.27
4	0.07	0.34
5	0.13	0.47
S → 6	0.11	0.58
7	0.09	0.67
⋮		⋮
		1.00

0.54

Q. A shopkeeper purchase a seasonal product at the begining of the season and cannot reorder. He purchase it at Rs. 220 each and he sold at Rs. 350 each, if the item remain unsold he can return it at Rs. 100 each. The goodwill loss is estimated at Rs. 25 each and the C_h is 10% of unit price. Find the optimum order qty to maximize profit.

Demand		
1	0.03	0.03
2	0.09	0.12
3	0.08	0.20
4	0.12	0.32
5	0.10	0.42
$P(S-1) \to$ 6	0.08	0.50
$P(S) \to$ 7	0.07	0.57
8	0.05	0.62
9	0.12	0.74
10	0.06	0.80
11	0.11	0.91
12	0.09	1.00

+0.09, +0.08, +0.12, +0.10

0.521

$C_h = 0.1 \times C$

$C_h = 0.1 \times 220 = 22$ Rs.

$p = S_p - C + C_b$

$= 350 - 220 + 25$

$\boxed{p = 155}$

$l = C - C_s + C_h$ → salvage cost or Resale value

$l = 220 - 100 + 22$

$\boxed{l = 142}$

$\left\{ \frac{p}{p+l} = \frac{155}{155+142} = 0.521 \right\}$

$\frac{p}{p+l} = 0.521$

$\frac{p}{p+l} < P(S)$

$\frac{p}{p+l} < (7)$ → Ans This is optimum Demand

Q. Find the shortage cost range when the holding cost is Rs. 3 and the demand and probability distribution is as given below with optimum stock level of 6 unit.

Demand	prob	Cumulative
1	0.08	0.08
2	0.10	0.18
3	0.12	0.30
4	0.13	0.43
5	0.07	0.50 ← $P(S-1)$
S → 6	0.06	0.56 ← $P(S)$
7	0.12	0.68
8	0.13	0.81
9	0.12	0.90
10	0.07	1.00

$P(S-1) < \frac{C_b}{C_b + C_h} \le P(S)$

$0.5 < \frac{C_b}{C_b + 3} \le 0.56$

Rs. $3 < C_b \le$ Rs 3.818

Ans will be within this

Service Level model

This model is preferred where the different cost factor involved with inventory are not known exactly, it is based upon probability theory and the amount of safety stock is kept according to the level of service management want to achieve.

Service level, $s = \left(\frac{\text{No. of units supplied without delay}}{\text{Total no. of units demanded}}\right)_{LT}$

$s \to 0$ to 1

$s\% \to 0$ to 100%

95% service level is the ~~std~~ standard value and it means that 95% of the customers order on an average are fullfilled during lead time and only 5% of the customers order on an avg are rejected during lead time.

When the demand during lead time may be approximated by a normal distribution with certain avg ($\bar{X}$ or μ) and std daviation (σ) then the reorder level is given by

$$\boxed{ROL = \bar{X} + Z\sigma}$$

$$\boxed{SS = Z\sigma}$$

where $\bar{X}$ = avg demand during lead time.

$$\boxed{\bar{X} = ADDLT = LT \times d}$$

σ = std daviation for the demand variation during lead time

Z = std normal variate whose value depend upon the service level required.

Z	Service level (%)
0	50%
0.84	80%
1.28	90%
1.645	95% (Min. Imp)
2.33	99%