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BREAK EVEN AND MINIMUM COST ANALYSIS

Often we have a choice b/w 2 alternatives where one of them may be more economical under one set of conditions & the other may be more economical under another set of conditions.

By altering the value of some one variable in the situation holding all other points of difference b/w the two alternatives constant, it is often possible to find a value for the variable which makes the 2 alternatives equally economical. This value may be described as the Break Even Point.

When the cost of 2 alternatives is affected by a common variable there may exist a value of the variable for which the two alternatives will have equal cost.

The cost of each alternative can be expressed as functions of the common independent variable & will be of the form

$TC_1 = f_1(x)$ & $TC_2 = f_2(x)$

where, x - a common independent variable affecting both alt 1 & alt 2.

TC_1 & TC_2 - are specified total cost for period of time for alt 1 & alt 2 respectively.

Solve for the value of x resulting in equal cost for alt 1 & alt 2 is accomplished by setting the cost functions equal i.e. $TC_1 = TC_2$

$\therefore f_1(x) = f_2(x)$

which may be solved for x.

The resulting value of x yields equal cost for the alternatives considered and is designated as the B.E.P.

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("The Brake Even Point" is that point of activity (sales volume) where total revenues & total expenses are equal. It is the point of zero profit.)

In other words, BEP is that specific level of activity or volume of sales where the firm break even, ie total cost equal total revenue. Hence it is the point where losses cease to occur while profits have not yet begun.

In case the firm produces & sells less than the level of break even point, it would incur losses; while if it produces & sells more than the level of BEP it makes profits.

The BEP, can be taken as the one indicating the minimum level of production or sales which the company has to undertake inorder to be economically viable.

[It reveals the relationship blw volume & cost of production on the one hand and revenues and ~~total expenses~~ profits obtained from the sales on the other hand.

It captures the relation of fixed costs, variable costs, the value of o/p, sales mix prices etc. to the profitability of the company.

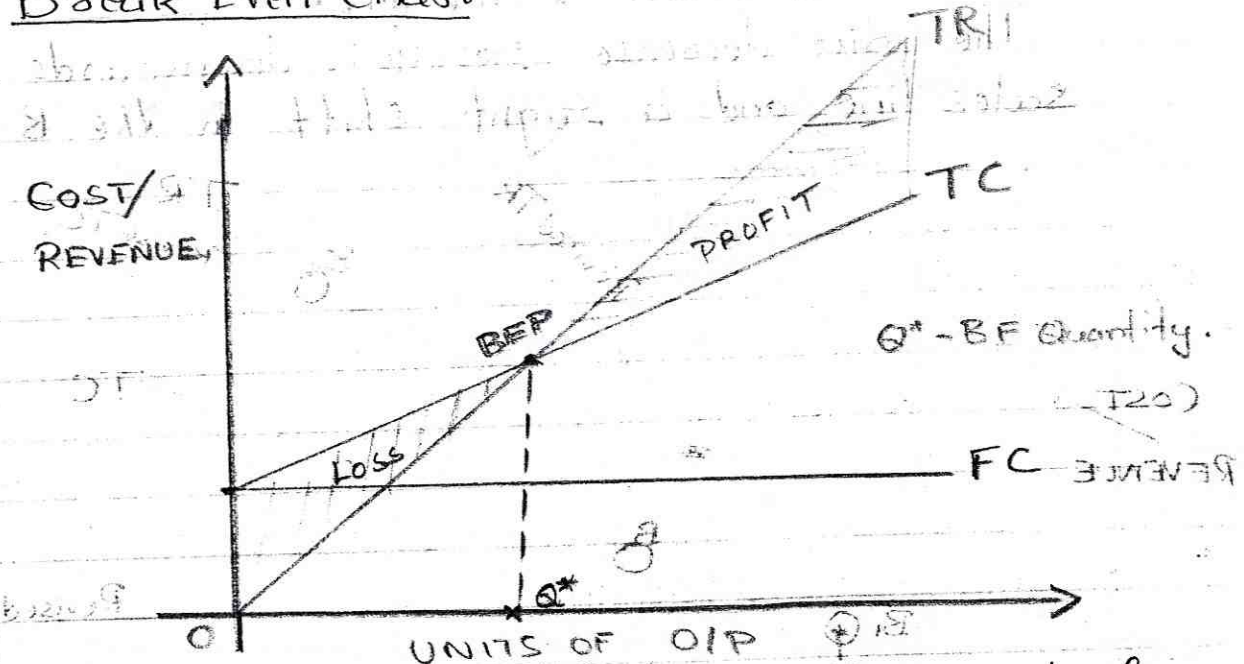
According to Maatz, Curry & Frank "A BE Analysis indicates at what level costs & revenue are in equilibrium".]

There are TWO approaches to representing a B.E.P.

i Graphical Method - Using B.E. Charts.

ii The Algebraic Method.

Break Even Chart



BE charts are often used for determining the following,

a. Break Even production volume
b. Profit appropriation for a given level of output
c. Choice of optimum level of o/p.
d. Impact of rate of changes in sales on costs & profits.

[NOTE- Preparation of BE chart is done using the income statement of the company.
Analytical Approach - Uses single Income statement
Statistical Approach - No. of income statements.]

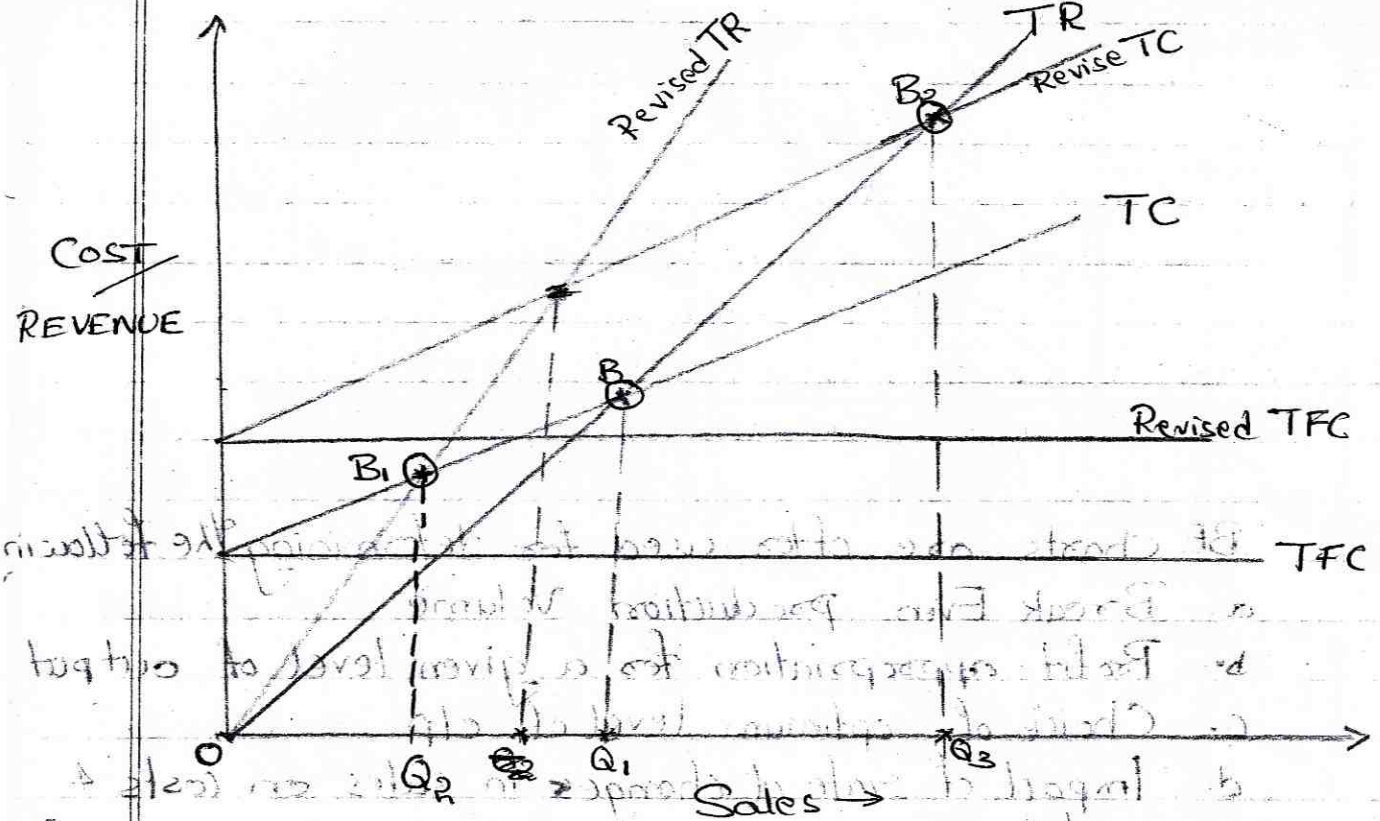
Changes in Costs & Price and B.E.P

The costs of a firm can rise either because of additional variable costs or increase in fixed costs. In both these cases the B.E.P will undergo a shift to the right.

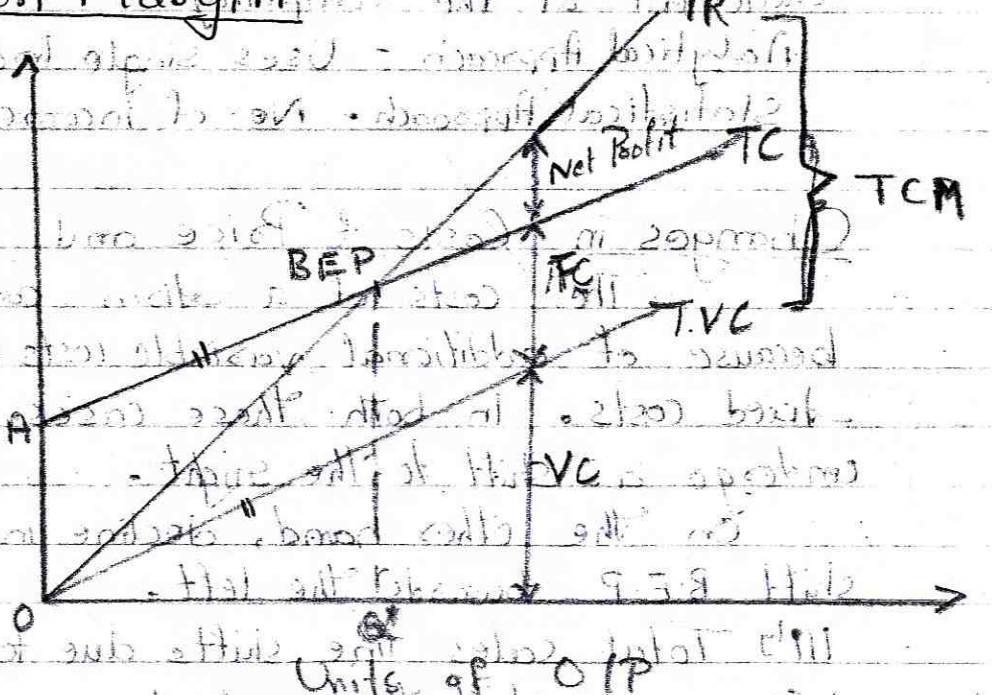
On the other hand, decline in these cost could shift B.E.P towards the left.

III'ly Total sales line shifts due to changes in price. A rise in price shifts the sales line upwards, & consequently,

B.E.P would shift to the left.
The price decrease results in downwards shifts in sales line and a right shift in the B.E.P.



Contribution Margin



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Business managers do not usually think profit in the economic sense i.e. the difference blw total revenue & total costs. Instead for short run, where a part of firms investment is a sunk investment, they use a more appropriate concept known as Contribution margin or Contribution profit.

It is the difference blw the total revenue (TR) & total variable cost (TVC)

Total Contribution Margin = TR - TVC
= Net Profit + Fixed Costs.

If the Total Net Profit = 0, then TCM = TFC and the firm achieves B.E.P.

Average Contribution Margin (ACM) is the difference blw unit price and avg. variable cost.

Break even occurs when avg. contribution margin (ACM) is equal to avg. fixed costs (AFC)

Assumptions in B.E. Analysis

The B.E.A is based on a set of assumptions, some of which are quite restrictive.

The assumptions underlying the analysis are the following,

1. It assumes that costs can be classified into fixed & variable costs, thus ignoring semivariable costs.
2. Sale price of the product is assumed constant, thus giving linearity property to total revenue curve.
3. It assumes constant rate of increase in VC, thereby imparting linearity to TC curve.
4. It assumes no improvement in technology & labour efficiency.

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5. Changes in input prices are also ruled out.
6. Production & Sales are Synchronised, in the sense there is no addition or subtraction from inventory.

Uses

The main advantage of using BEA in managerial decision making can be the following,

1. It helps in determining the optimum level of o/p, below which it could not be profitable for a firm to produce.
2. It helps in determining the target capacity for a firm to get the benifit of minimum unit cost of production
3. With the help of the B.E.A, the firm can determine minimum (cost) for a given level of o/p.
4. It helps in deciding which products to be produced and which to be bought by the firm.
5. Plant expansion or contraction decisions are often based on the B.E.A of the perceived situation.
6. Impact of changes in prices and costs on profits of the firm can also be analysed with the help of B.E technique.
7. Sometimes a management has to take decisions regarding dropping or adding a product to the product line.
8. If it evaluates the financial yield from a project, it helps in the choice b/w various alternative projects.
9. B.E.A can be used in finding the S.P. which could prove most profitable for the firm.

From finding the B.E.P., the BEA helps in establishing the point wherefrom the firm can start payment of dividend to its shareholders.

Limitations

1. Often we find that i/p prices, like material prices wages etc undergo a change over time. Since B.E.A is based on past data, such data need to adjusted for changes in i/p prices. These are avoided because of their complexity in analysis.

2. The B.E. chart are drawn on basis of given product prices. Infact, the product prices change frequently. The non inclusion in changes in prices is basically due to difficulty of precisely estimating the sales volume at various prices. But this non inclusion of product prices imparts its share of unrealism to the results.

3. The B.E.A is static in nature, in the sense that it assumes a constant relationship of o/p to costs & revenue.

4. It is assumed in the analysis that the relative share of different products in the total o/p remains the same. In practical one finds frequent changes in the composition of demand and product mix.

5. It is common knowledge that profits depend on various factors like technological improvements, managerial effectiveness etc and not only on level of o/p. The B.E.A by its assumptions only on o/p gives a partial view

6. Since B.E.A is generally based on accounting data, it suffers from many limitations, like omission of imputed costs, scientifically determined depreciation etc

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7. The B.E.A ignores selling costs and only concentrates on the production costs.

8. It is not necessary that o/p in the particular period results in costs only during that period. Some costs, like maintenance, may partly be due to o/ps in the earlier periods. While postponing the maintenance costs in the current period would result in assigning the maintenance costs to the o/p of the subsequent periods, though these obviously do not belong to o/p in that period.

Determination of Break Even Point

Before we take up the B.E problems for solution, let us define the following symbols.

Q = Units of output (physical); Q_B - B.E quantity.

P = Price per unit or Avg. Revenue (assc. constant)

T.R = P x Q = Total Revenue.

TFC = Total Fixed Cost

TVC = Total Variable Cost

T.C = Total Cost = [TFC + TVC or TFC + Q(AVC)]

AFC = Avg. Fixed Cost

ACM = Avg. Contribution Margin [= P - AVC]

TCP = Total Contribution Profit [= T.R - TVC or Q (ACM)]

TNP = Total Net Profit [= (TR - TC)]

B = Break Even Point

To determine B.E.P, we have,

$$TR = TC$$

which may be written as,

$$P \times Q_B = TFC + Q_B(AVC)$$

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$Q_B (P - AVC) = TFC$

∴ Break Even Quantity would be,

$$Q_B = \frac{TFC}{P - AVC} \quad \text{——— (1)}$$

(1) can be written in terms of contribution margin;

$$Q_B = \frac{TFC}{ACM} \quad \text{——— (2)}$$

Eq. 2 is basic equation and can be expressed in 3 ways;

(1) As No. of units of goods sold
(2) As a Rupee Volume of sales
(3) As a Percentage of plant capacity.

Each of these needs a different expression of the contribution margin.
For this we take an example

1. A costal ship can carry a maximum of 1,00,000 passengers per month at a fee of Rs 850. Variable cost per passenger is Rs 100 while the fixed cost are Rs. 75,00,000 per month. Find the B.E.P of Sales Volume of Ship.

Find BEP as (a) Quantity sold
(b) Sales Volume
(c) % of Capacity.

(a) In terms of BE Quantity.

$$Q_B = \frac{TFC}{P - AVC} = \frac{Rs\ 75\,00\,000}{850 - 100}$$

$$= \underline{10\,000 \text{ passengers}}$$

(B) In terms of Rupee volume of sales,

(a) Contribution Margin as the fraction of price or revenue that contributes to payments of fixed cost & profit.

$$S_B = \frac{TFC}{1 - (AVC/P)}$$

or $$S_B = \frac{TFC}{1 - (TVC/TR)}$$

$$= \frac{75\,00\,000}{1 - \left(\frac{100}{850}\right)}$$

$$= \underline{85,00,000}$$

(c) As % of Capacity

Here we need to multiply Avg. contribution margin (ACM) by plant capacity. This will provide us max. rupee value of sales that plant can contribute to fixed cost & profit.

Let us express Plant Capacity as Q_{max}

$$\%_B = \frac{TFC}{(P - AVC)\,Q_{max}} \times 100$$

Also we can express as, $\%_B = \frac{Q_B}{Q_{max}} \times 100$

$$= \frac{75,00,000}{(850-100)\,1,00,000} \times 100$$

$$= \frac{7500000}{750 \times 100000} \times 100 = \underline{10\ \%}.$$

2. A retailer plans to sell a baby elephant toy at a local fair. This purchase ~~site~~ price of the toy is Rs 7/- per piece with a privelage of returning the unsold toys. The booth rent of the fair is Rs 2500 payable in advance. S.P. of the toy is Rs 12/piece. Find out the no. of toys which must be sold to break even & also the B.E sales value.

TFC = 2500 Rs

AVC = Rs 7/-

SP = P = Rs 12/-

(i) $Q_B = \frac{TFC}{P - AVC}$

$= \frac{2500}{12-7} = \underline{500 \text{ units}}$

(ii) Break Even Sales Value

$S_B = Q_B \times SP$

$= 500 \times 12$

$= \underline{6000 \text{ Rs}}$

3. The following data is regarding a company. Find the B.E.P in terms of sales volume.

Sales : Rs 1,00,000

Fixed cost : Rs 2,00,000

Variable Cost : Rs 50,000

Wkt., At B.E

$TR = TC$

$Q_B = \frac{TFC}{P - AVC}$

$$Q_B \times P = \frac{TFC}{1 - \frac{AVC}{P}}$$

$$S_B = \frac{TFC}{1 - AVC/P}$$

$$\left[\frac{TVC}{Sales} = \frac{AVC \times Q}{P \times Q} = \frac{AVC}{P}\right]$$

$$= \frac{2,00,000}{1 - \frac{50,000}{1,00,000}}$$

$$= \frac{2,00,000}{0.5}$$

$\therefore S_B = Rs\ 4,00,000/-$

1. A firm has purchased a plant to manufacture a new product, the cost data for which is given below

Estimated annual Sales — 24000 units

Estimated costs:

Material	Rs 4/unit
D. Labour	Rs 0.60/unit
Overhead	Rs 24,000/year
Administrative expenses	Rs 28,800/year
Selling expenses (Fixed)	15% of Sales

Calculate SP, if profit/unit is Rs 1.02

Find out the B.E.P. in terms of units of O/P

i. Estimated cost of production for 24000 units

Material @ 4/unit	96000
Dir. Labour @ 0.60/unit	14400
	24000

Estimated cost of production for 24000 units

Material @ 4/unit	96000
Direct Labour @ 0.06/unit	14400
Overhead @	24000
Administration expenses	28800
	Rs 1,63,200

∴ Total Cost of Production = Rs 163200

Total Cost = Total Cost of Production + Total Selling Cost

= 163200 + 15% of ~~163200~~ ✗

Profit on 24000 units (@ Rs 1.02 per unit)

= 24000 × 1.02 − Rs 24,480

Let the Sales Volume = Rs X

Then Rs X = Total Cost + Profit

$$X = \left(163200 + \frac{15}{100}X\right) + 24480$$

$$Rs\ X\left(1 - \frac{15}{100}\right) = Rs\ 187680$$

$$\frac{85}{100}X = 187680$$

$$X = 187680 \times \frac{100}{85}$$

Thus total Sales Volume = Rs 220800

$$\text{Profit Value of Sales Volume} = \frac{24480}{220800}$$

$$= Rs\ 0.20$$

(ii) At BEP, the units sold of the product should be such that their total cost is covered by total receipts from their sales. The B.E.P sales are where

Total Sales Volume = Total Cost

Units Sold × S.P = Total Cost

$$\frac{\text{Total Cost}}{\text{Selling Price/unit}}$$

$$= \frac{163200 + 15\% \text{ of } 220800}{9.20}$$

$$= \frac{196320}{9.20}$$

$$= 21,339 \text{ units}$$

OR:

$$\text{B.E.P Sales Volume} = \frac{\text{TFC} + \text{Total Selling expense}}{\text{SP} - \text{AVC}}$$

$$= \frac{(24000 + 28800) + 0.15 \times 220800}{9.20 - 4.60}$$

$$= \frac{18,6279}{\text{units}}$$

5. A manufacturer sells his product at Rs 5/- each, Variable costs are Rs 2/unit & the FC amount of Rs 60000 F

i. Calculate the B.E.P

ii. What would be the profits if firm spends Rs sells 8000 units

iii. What could be the BEP if the firm spends Rs 3000 on advertising.

iv. How much should the manufacturer sell to make profits of Rs 30000?

i. BEP, $Q_B = \frac{TFC}{S - AVC}$

$= \frac{60\,000}{5 - 2}$

$= 20\,000$ units.

ii Profit = TR − TC

$= [5 \times 30\,000 - (60000 + 2 \times 30\,000)]$

$= 150\,000 - 120000$

$= \underline{\text{Rs } 30\,000/-}$

iii B.E.P $= \frac{TFC}{S - AVC} = \frac{60000 + 3000}{5 - 2}$

$= \frac{63\,000}{3} = \underline{1000 \text{ units}}$

iv. Target Sales Volume $= \frac{FC + \text{Target Profit}}{S - AVC}$.

$= \frac{63\,000 + 30000}{5 - 2}$

$= \underline{31\,000 \text{ units}}$

6. ABC Company manufactures a toy which has a variable cost of Rs 10/unit & a SP of Rs 15/unit. Fixed costs are budgeted at Rs 40 000

a. Calculate the nos of toys needed to be sold in order to breakeven.

b. What is the B.E.P sales volume.

c. How many toys are to be sold to generate a profit of Rs 15000/-.

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a $Q_B = \frac{TFC}{SP - AVC}$

$= \frac{40\,000}{15 - 10}$

$= 8000$ toys.

b. BEP sales volume $= 8000 \times 15$

$= 120\,000$

c. To generate a profit of Rs 15000

Sales $= \frac{TFC + Profit}{SP - AVC} \times SP$

$= \frac{40000 + 10000}{15 - 10} \times 15$

$= \frac{55\,000}{5} \times 15$

$= 165000$ Rs

MARGIN OF SAFETY (MOS)

"It is the excess of budgeted or actual sales over the break even sales volume"

Mathematically,

Margin of Safety = Actual Sales - Break Even Sales.

At the BEP, the firm is just able to cover the fixed costs, besides the variable cost.

In case the BE actual sales is more than the BEP the firm is able to make profits.

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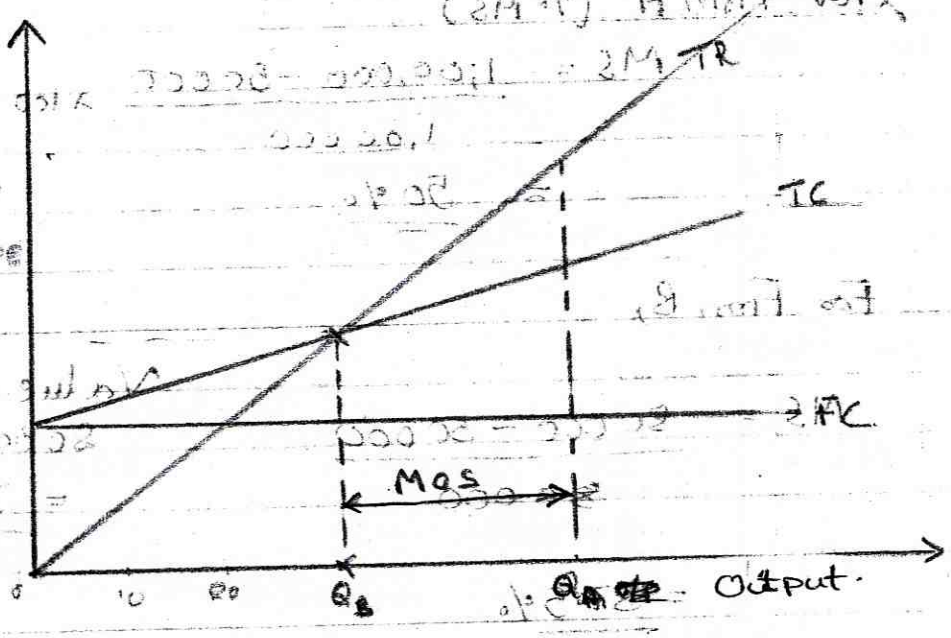
In other words greater the saffey margin, greater could be the profits.

It is important for a firm to have a reasonable saffey margin. With a low saffey margin the firm is running under the risk of making losses during the phases of reduced business activity.

The low saffey margin may be due to the lower actual sales or the fixed costs are very high.



Q_B - Break Even Quantity

Q_A - Actual Quantity

Saffy Margin = $Q_A - Q_B$

Margin of Saffy can be expressed as percentage value also,

$$MS = \frac{Q_A - Q_B}{Q_A} \times 100 \quad \%$$

Find the margin of saffey of a firm A & B given the following data

	Firm A	Firm B
Actual total Sales	1,00,000	1,60,000
Budgeted Sales	1,00,000	80 000
B.E Sales	50000	50 000

Which company is better placed cost to its MS & Why?

Based on Budgeted Sales

For Firm A (% MS)

$$MS = \frac{1{,}00{,}000 - 50000}{1{,}00\,000} \times 100$$

$$= 50\%$$

Value = 1,00,000 - 50000

= 50 000/-

For Firm B,

$$MS = \frac{80\,000 - 50\,000}{80\,000}$$

$$= 37.5\%$$

Value = 80000 - 50000

= 30000 Rs

Based on Actual Sales

For Firm A,

$$MS = \frac{100000 - 50000}{50000}$$

$$= 50\%$$

Value = 100 000 - 50000

= 50,000 Rs

For Firm B,

$$\frac{60\,000 - 50000}{60000}$$

$$= 16.7\%$$

60 000 - 50000

= 10,000 Rs

It is clear from MS(%) and MS value that, For the above analysis Firm A has a better safety margin than Firm B.

2. If the fixed cost of a company are Rs 60000/- the variable cost Rs 10/- per unit of O/P, & the S.P. is Rs 20/- per unit. Find the B.E. point. ii) If the company sells 10,000 units of the product, find the saffty margin of the company.

$$BEP\ Q_B = \frac{FC}{SP - AVC} = \frac{60000}{20-10} = 6000 \text{ units.}$$

$$Q_S = Q_B \times S.P. = 6000 \times 20 = 1,20,000 \text{ Rs.}$$

$$\text{Saffty Margin for Company} = \frac{\text{Actual Sales} - \text{BEP Sales}}{\text{Actual Sales}} \times 100$$

$$= \frac{10000 - 6000}{10000} \times 100$$

$$= 40\%$$

Break Even Analysis - Comparision of Alternatives

1. A 50 HP motor is required to drive a pump to remove coals from a tunnel. The unit will be needed for a period of 4 years. Two alternatives are under consideration. Alternative 'A' calls for the construction of a power line & purchase of the electric motor at a total cost of $4900. The salvage value of this equipment after 4 years is estimated to be $700. The cost of the current for the per hour of the operation is estimated to be $2.94 per year and maintenance is estimated at $420 per year.

Alternative B calls for purchase of a diesel engine pump set at a cost of $1925. It will have no salvage value at the end of 4 years period. The cost of diesel per hour of operation is estimated at $1.47 maintenance is estimated at $0.53 per hour of operation and the cost of the wages chargeable when the engine runs is $2.08 per hour.

How many hours per year the two machines have to run so that the 2 alternatives incur equal costs. If the no. of hours of operation is estimated at 100 year which alternative is more economical. Take interest rate at 10% per year.

Solution

Let X be the no. of hours of use of the operation per year.

Let TC_A = Total equivalent annual cost of Alt. A

TC_B = Total equivalent annual cost of Alt. B

TC_A = Capital recovery + Maintenance Cost/year + Current cost/year.

$CR(i)_A = (P - R_n)(A/P, i, n) + F_i$

$= (4900 - 700)(A/P, 10, 4) + 700 \times 0.10$

$= \$1395$

CR - Capital Recovery

$TC_A = 1395 + 420 + 2.94 \times x$

$= 1815 + 2.94x$ ——— (1)

$TC_B = CR(i)_B + \left[\begin{array}{l}\text{Cost of diesel +} \\ \text{Maintenance + wages}\end{array}\right] \times$ No. of hours.

$CR(i)_B = (P-R)(A/P, i, n) + F.i$

$(1925-0)(A/P, 10\%, 4) + 0 \times i$

$= \$607.28$

$TC_B = 607.28 + (1.47 + 0.53 + 2.8) \times x$

$= 607.28 + 4.8x$ ——— (2)

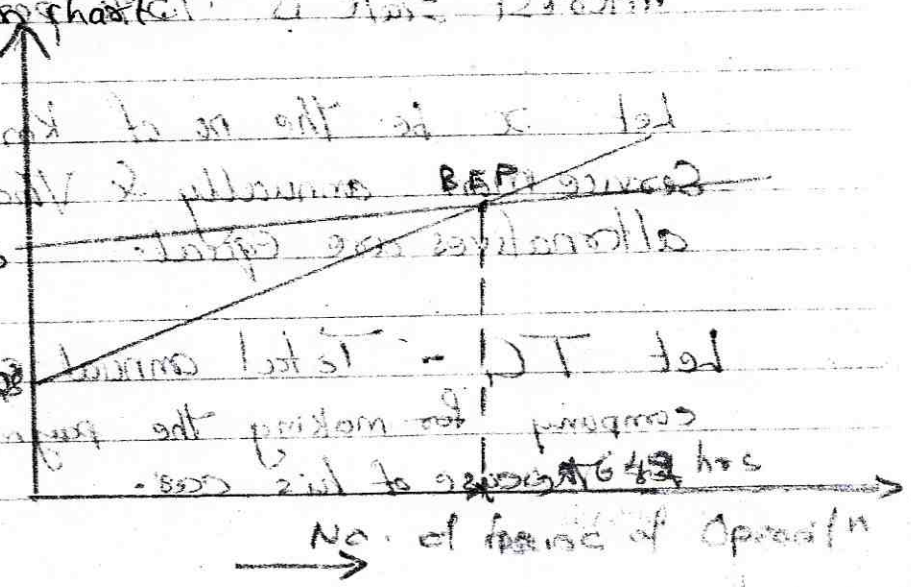
Now if we equate TC_A & TC_B i.e. 1=2 then we will get 'x' is the value of no of hours of operation of alt. A & B at which the costs are equal i.e. BEP.

$\therefore TC_A = TC_B$

$1815 + 2.94x = 607.28 + 4.8x$

$x = 649$ hrs

B.E.P marked on chart.



From the chart it is very clear that if the actual no. of hours of operation is less than 649 hrs, At B is more economical (diesel engine) If the no. of hours of operations is greater than 649 hrs. then AtA is economical (electrimotor)

When the no. of hrs of operation is 100 alternative B is economical.

2. A company may furnish a car for use by a service man for transportation b/w its properties or the company may pay the service man for the use of his car at a rate of $0.16/km for this purpose.

The following estimated data apply to company furnished cars. A car costs $4000 and has a life of 4 years and a trade in value of $800 at the end of that time. Monthly storage costs for the car is $20 and cost of fuels, maintenance 4 tyres is $0.06 per kilometer.

How many km the service man must travel annually by car for the cost of the two methods of providing transportation to be equal if the interest rate is 15% per year.

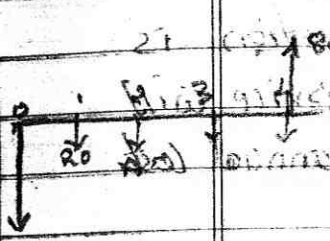
Let x be the no. of km travelled by the service man annually so that the costs of both alternatives are equal.

Let TC - Total annual equivalent cost of the company for making the payment to the serviceman for the use of his car.

TC_2 = Total annual equivalent cost of company furnishing its car to service man.

$TC_1 = 0.16 \times x$ ——— (1)

TC_2 = CR(i) + Annual Storage Cost + Annual cost of fuel tyres & maintenance.



$CR(i) = (4000 - 800)(A/P, 15\%, 4) + 800 \times 0.15$

$= \$1241$

$TC_2 = 1241 + 20 \times 12 + 0.06 \times x$

$= 1481 + 0.06x$ ——— (2)

At BEP,

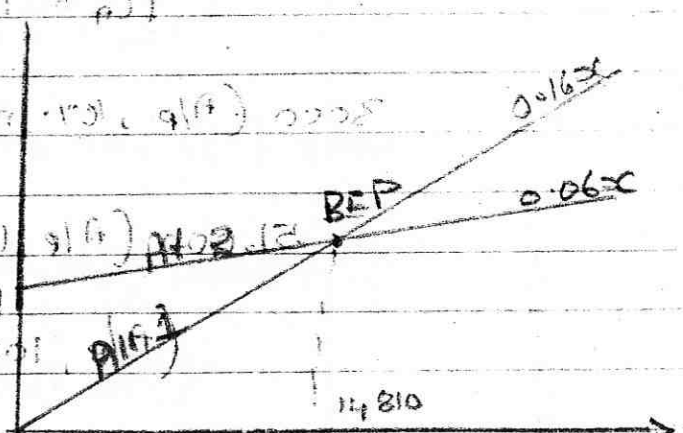
$TC_1 = TC_2$

$0.16x = 1481 + 0.06x$

$x = 14810$ Km

If $x < 14810$ km, Alt 1 is recommended

If $x > 14810$ km, Alt 2 is recommended.



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3 M/c A costs Rs 3,000/- has zero salvage value at any time & labour cost per unit of product on it is Rs 17/-. M/c B costs Rs 54,000 and has a zero salvage value at any time & labour cost per unit of production is Rs 12.50. The interest rate is 10%. If the annual rate of production is 3000 units with how many years of service will the two m/c break even in equivalent annual cost.

Solution

Let TC_A - Total equivalent annual cost of m/c A

TC_B - " " " " " m/c B

At an output of 3000 units per year

$$TC_A = 3000(A/P, 10, n) + 17 \times 3000 - 3000(A/P, 10, n) + 51000$$

$$TC_B = 54000(A/P, 10\%, n) + 12.50 \times 3000 - 54000(A/P, 10, n) + 37500$$

For the two m/c's to break even,

$$TC_A = TC_B$$

$$3000(A/P, 10\%, n) + 51000 = 54000(A/P, 10\%, n) + 37500$$

$$51,000(A/P, 10\%, n) = 13500$$

$$(A/P, 10\%, n) = 0.2647$$

$$\frac{i(1+i)^n}{(1+i)^n - 1} = 0.2647$$

$$= \frac{0.1 \times 1.1^n}{1.1^n - 1} = 0.2647$$

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$$\frac{0.1}{1-\frac{1}{1.1^n}} = 0.2647$$

$$\frac{\frac{1}{1.1^n}}{1-\frac{1}{1.1^n}} = \frac{0.1}{0.2647}$$

$$\frac{1}{1.1^n} = 1 - \frac{0.1}{0.2647} = 0.6222$$

$$1.1^n = 1.6078$$

$$n \log 1.1 = \log 1.6078$$

$$n = 4.98 \text{ year} \simeq 5 \text{ years}$$

If $n = 6$,

$TC_A = 51688$

$TC_B = 49898$

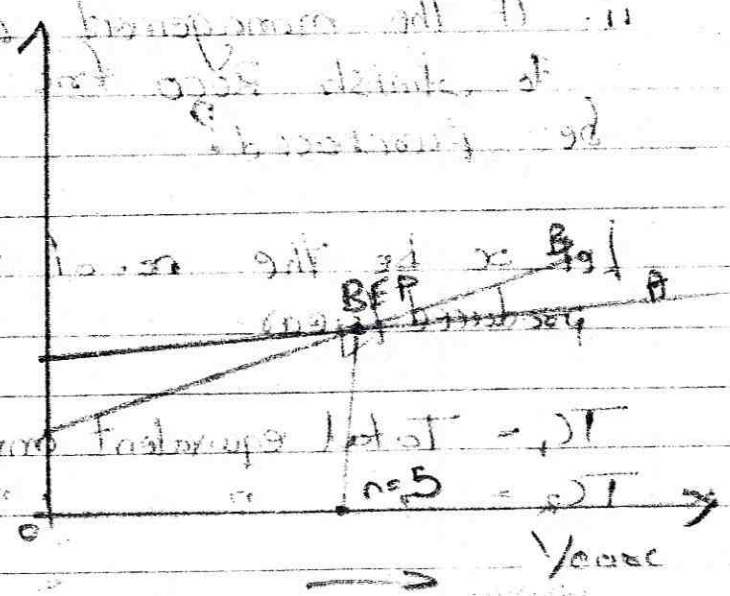
If $n = 4$,

$TC_A = 51946$

$TC_B = 54534$

If $n < 5$ years then M/C A is economical.

If $n > 5$ years then M/C B is economical.



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4. A sheet metal company is considering the purchase of an automatic feed m/c for a certain phase of finishing process.

The m/c has initial cost of $23,000 a salvage value of $4000 & life of 10 yrs If the m/c is purchased one operator is req'd. at the rate of (cost) $12 an hour. The O/p with this m/c will be 8 tons/hr. Annual maintenance & operation cost of the m/c is expected to be $3500.

Alternatively, the company can purchase a less sophisticated manual feed m/c for $8000, which has no salvage value & life of 5 years. However with this alternative 3 workers will be required at a cost of $8 per hour each of the m/c will have an annual maintenance and operating cost of $1500 O/p is expected to be 6 tons per hour for this m/c. All ~~investment~~ invested capital return 10% per year.

i. How much sheet metal must be finished per year in order to justify the purchase of the automatic ~~feed~~ m/c

ii. If the management anticipates a requirement to finish 2000 tons per year which m/c would be purchased?

Let x be the no. of tons of sheet metal produced/year.

TC_1 = Total equivalent annual cost of automatic feed m/c

TC_2 = " " " " " manual feed m/c.

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TC_1 = $CR(i)_1$ + Annual maintenance & operation cost + Annual labour cost

Annual Labour cost = 1 hr - 8 tons

$\left(\frac{x}{8}\right)$? - x tons

Labour cost = $\frac{x}{8} \times 12$

= 1.5 x Rs

TC_1 = $[(23000-4000)(A/P, 10\%, 10) + 4000 \times 0.10]$

+ 3500 + 1.5x

6992.25 + 1.5x ——— (1)

TC_2 = $CR(i)_2$ + Annual Maintenance & Operations Cost + Annual labour costs.

$\left(\frac{x}{6}\right)$? - x tons

Labour Cost = $\frac{x}{6} \times (8 \times 3)$ = 4x

TC_2 = 8000$(A/P, 10\%, 5)$ + 1000 + 4x

= 3610.4 + 4x ——— (2)

$TC_1 = TC_2$

6992.25 + 1.5x = 3610.4 + 4x ——— (3)

x = 3353 tons ——— (4)

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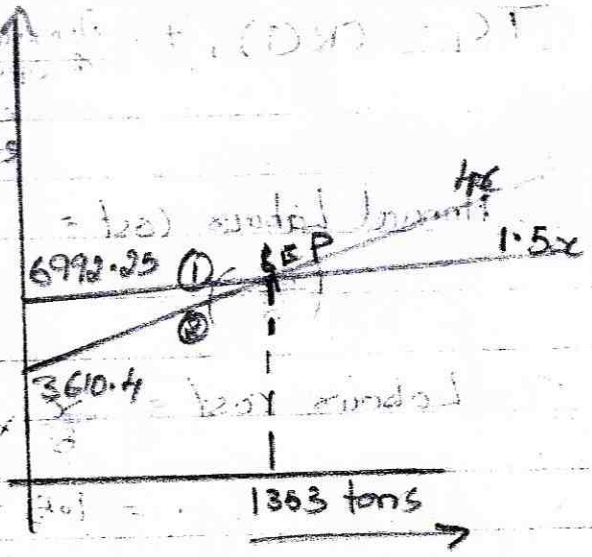
If $x < 1353$ tons manual feed m/c is recommended

If $x > 1353$ tons then auto feed m/c is recommended

If $x = 2000$ tonnes auto feed m/c is recommended.



5. A contractor is offered his choice of either gasoline, diesel or butane engine to power a bulldozer he is to purchase.

The gasoline engine will cost $ 2,000 & will have a estimated maintenance cost of $200 per year and it will consume $3.6 worth of fuel per hour of operations.

The diesel engine will cost $2800 and will have cost an estimated $240 per year to maintain and will consume $ 3.30 worth of fuel per hour.

The butane engine will cost $3300 and will cost $315 per year to maintain & will consume $2.9 worth of fuel per hour of operation.

Since the salvage value of the engine is identical it can be neglected. All other costs associated with the 3 engines are equal and the interest rate is 15%. The service life of each engine is 5 years.

(a) Plot the defined annual cost of each engine as a function of no. of hours of operations/year.

(b) Find the range of no. of hours of operation for which it would be most identical to specify the gasoline, diesel & butane engines.

Let x be the no. of hours of operations of each engine per year.

Let TC_1 = Total equivalent annual cost of gasoline engine

TC_2 = " " " " " diesel engine

TC_3 = " " " " " butane engine

$$TC_1 = 2000\,(A/P, 15\%, 5) + 200 + 3.6x$$
$$= 796.64 + 3.6x \quad \text{——— (1)}$$

$$TC_2 = 2800\,(A/P, 15\%, 5) + 240 + 3.3x$$
$$1075.3 + 3.3x \quad \text{——— (2)}$$

$$TC_3 = 3300\,(A/P, 15\%, 5) + 315 + 2.9x$$
$$1299.5 + 2.9x \quad \text{——— (3)}$$

The B.E. b/w the alternatives can be found by equating the alternatives at a time in pairs.

(1) & (2) $\quad TC_1 = TC_2$

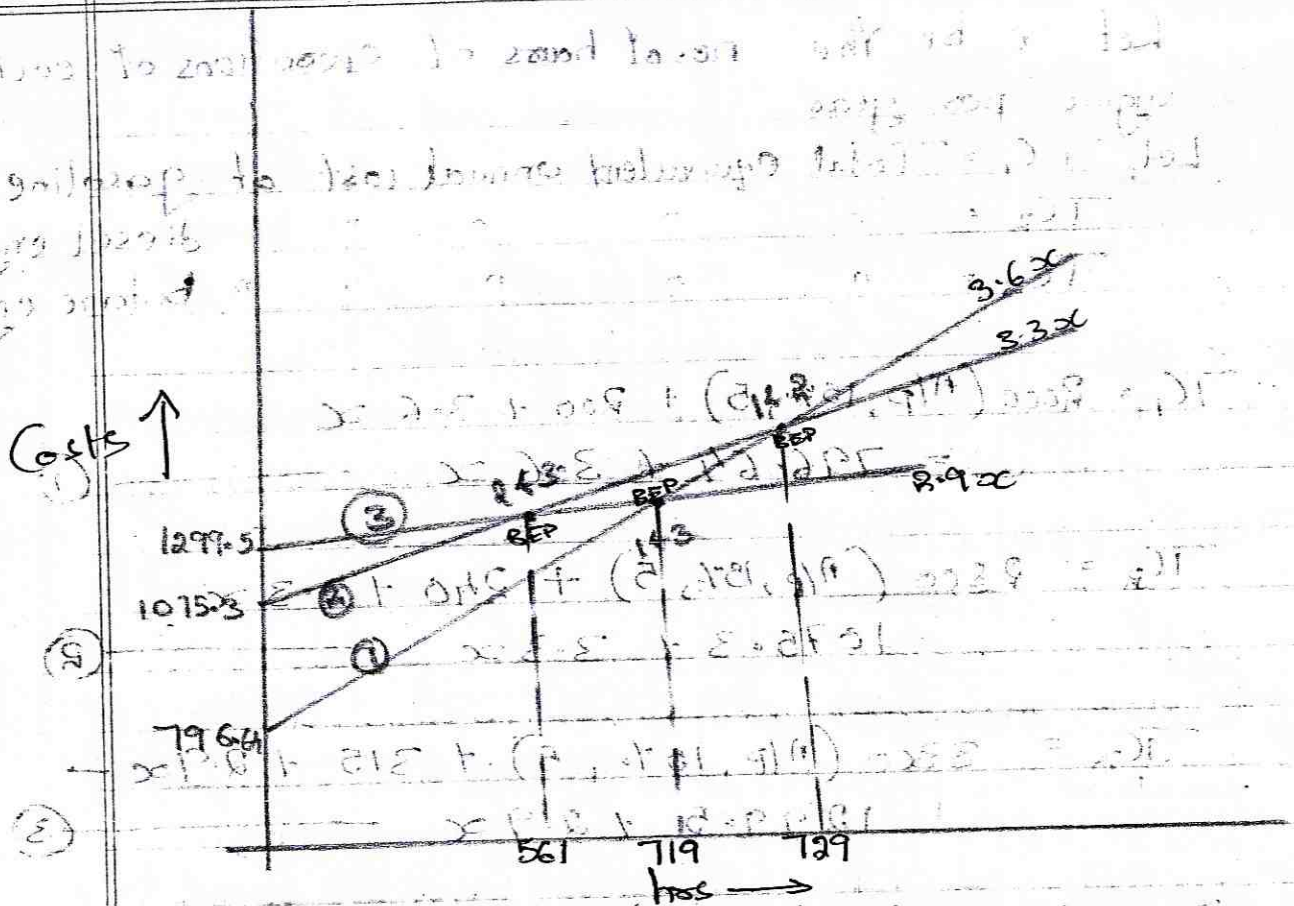
$$796.64 + 3.6x = 1075.3 + 3.3x$$
$$\therefore x = 928.86 = \underline{929 \text{ hrs}}$$

(2) & (3) $\quad TC_2 = TC_3$

$$1075.3 + 3.3x = 1299.5 + 2.9x$$
$$\therefore x = \underline{561 \text{ hrs}}$$

(3) & (1) $\quad TC_3 = TC_1$

$$1299.5 + 2.9x = 796.64 + 3.6x$$
$$\therefore x = \underline{719 \text{ hrs}}$$



Upto 719 hrs, go for alt 1 - gasoline

Upto Greater than 719 hrs go for alt-3 - Butane engine

Donot go for diesel engines (alt 2).

COMPARISION OF INVESTMENT ALTERNATIVES

B.E analysis can be used for comparing the different alternatives that are available for producing a particular products or achieving a desired objective. Because ~~Break even~~ in practice there may be more than one technique available for producing a particular product. These techniques differ from each other in terms of the costs associated with them at different levels of o/p.

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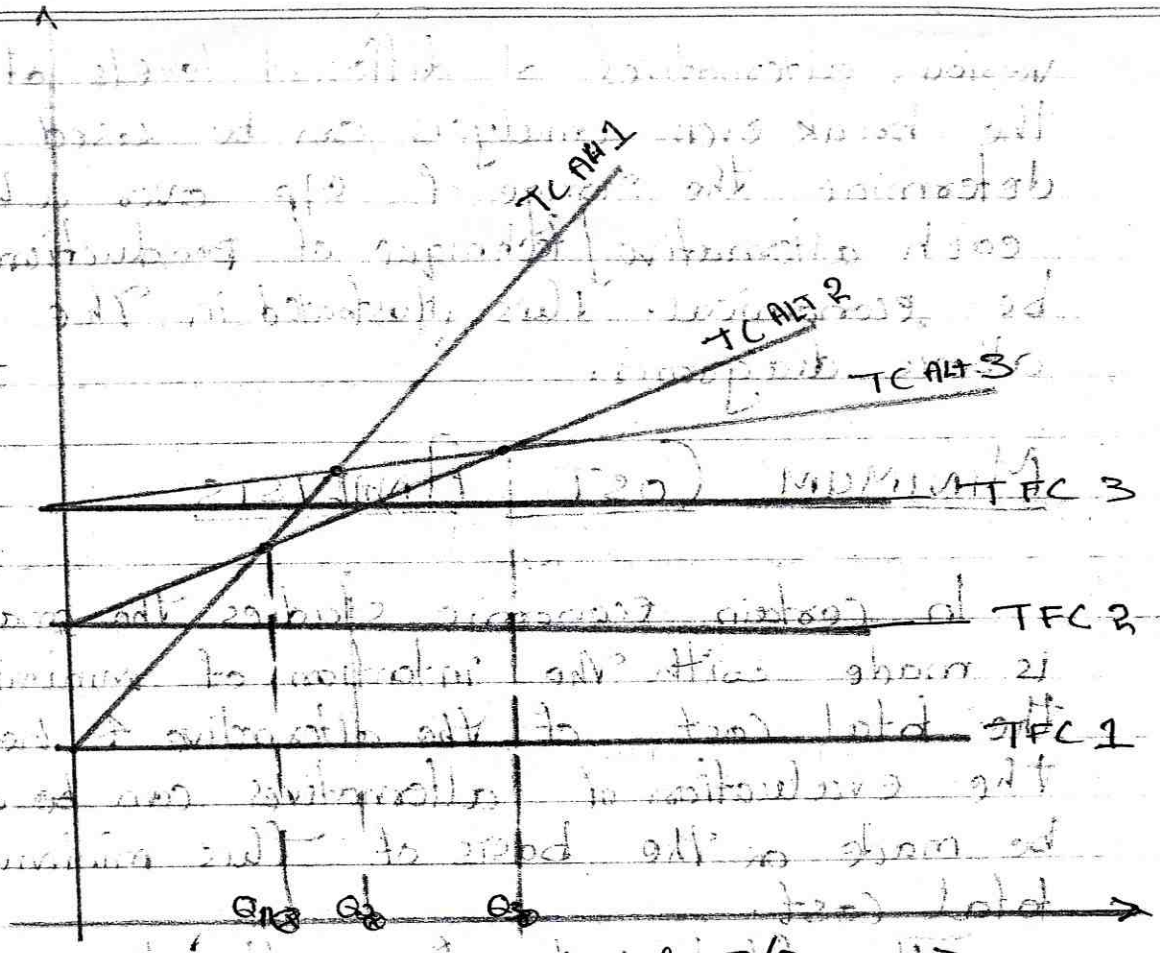

At lower levels of O/P manual operated techniques may be profitable. Since they require minimum FC. with the result, the business B.E.P will make a profit at a lower level of O/P. These techniques will not be profitable at higher levels of O/P because of the higher VC.

On the other hand, at higher levels of O/P automation techniques will be more profitable because of the lower variable cost (VC). but they will not be profitable at lower levels of O/P, since they require higher FC. With the result, the business breakevens and makes a profit at a higher vol. of O/P as compared to manual operated techniques.

So by solving the costs associated with the