9.1 INTRODUCTION

The study of the relation of cost volume and profit is called Break Even Analysis (BEP). Under break-even analysis, required level of output is determined in order to generate planned level and profit. A business is said to be break-even, when its income equals to expenditure. The level of output, where income is equal to expenditure is called Break Even Point. When the production is above the volume of break-even point, company increase profit, however, if the volume of production is below break-even point, the company makes loss. Break-even analysis is very much applicable in “Profit planning” i.e. determine the quantity of production to achieve desired profit. Production above BEP is profit but production below BEP is loss.

9.1.1 CALCULATION OF BREAKEVEN POINTS

As discussed above, the break-even point is a production level where total cost is equal to total revenue. The total cost includes fixed cost and total variable cost.

\[ T_c = F_c + TV_c \]

Where, \( T_c \) = Total cost
\( F_c \) = Fixed cost
\( TV_c \) = Total variable cost

Fixed cost \( (F_c) \) is that cost which must be borne irrespective of the level of output i.e. they are the permanent expenditure that a company has to borne whether it produce product or not. Example-depreciation cost of machinery, insurances cost, rent, staff salary, municipal tax etc. The fixed costs are so called because they do not change during the short period eg. for one fiscal year. In long run all cost are variable. Hence assuming fixed cost fixed in nature, BEA can be regarded as short-term analysis. Variable cost \( Vc \) is that cost which varies directly with output. These are per unit cost relating to materials, supplies wages etc. In breakeven analysis (BEA) variable cost are assumed to vary in a lines relationship with the production volume. This assumption is made for the simplicity of understanding the techniques of breakeven analysis. In fact these variable cost curve are shaped, signifying that these cost are high up to a certain point and decline with every addition of output unit they reach a minimize level and then starts raising again. The fixed cost and variable cost in relation to volume of output are shown below.

![Graph showing fixed and total variable units](image-url)
Generally total variable cost is determined as
\[ TV_C = V_c \times Q \]  
Where, \( V_c \) = Variable cost/unit  
\( Q \) = Quantity of output

\[ \therefore T_C = TV_C + F_C = (V_c \times Q) + F_c \] Where, \( F \) = Fixed cost.

Now at a breakeven point, total cost is equal to total revenue. Total revenue is obtained by multiplying quantity of output by selling price per unit. If \( S_p \) is the selling price per unit and \( Q \) is the quantity.

\[ TR (Total Revenue) = Q \times S_p \]  
\[ \therefore \text{At breakeven point, Total Revenue = Total cost i.e.} \ TR = TC \]

From equation 1, 2, 3 and 4

\[ Q \times S_p = F_c + Q \times V_c \]

\[ \therefore Q = \frac{F_c}{S_p \times V_c} \]

Breakeven quantity is given by the equation 5

The relationship \( S_p - V_c \) is also called **contribution margin.** Now the BEP quantity is also given by.

\[ \text{BEP (Qty)} = \frac{\text{Fixed cost}}{\text{Contribution Margin}} \]

Multiply equation (5) by \( S_p \) both side we get,

\[ Q \times S_p = \frac{F_c}{S_p \times V_c} \times S_p \]

Here, \( Q \times S_p \) is also called as **breakeven sales volume.** The breakeven sales volume is also rearranged as:-

\[ \text{BEP (sales volume)} = \frac{\text{Fixed cost}}{S_p \times \left(1 - \frac{V_c}{S_p}\right)} = \frac{\text{Fixed cost}}{\text{Variable cost/unit}} \left(\frac{1}{S_p} - \frac{1}{V_c}\right) \]

The equation 5 & 7 are generally used for calculating breakeven point regarding production output i.e. Quantity or Sales volume.

The production level required to obtain targeted profit is given by.

\[ \text{Output (Production target)} = \frac{\text{Fixed cost} + \text{Targeted profit}}{\text{Selling price/unit} - \text{Variable cost/unit}} = \frac{F_c + \text{Profit}}{S_p - V_c} \]

**Solved Example 1**

Given \( F_c = 30000 \)  
\( S_p = 1.75 \)  
\( V_c = 1 \)

(a) Find out BEP in quantity and Rs.
(b) Quantity to be produced for getting 20000 profits.

**Solution:**

(a) Breakeven quantity (Q) = \( \frac{F_c}{S_p - V_c} = \frac{30000}{1.75 - 1} = 40000 \) unit

Now breakeven revenue = \( Q \times S_p = 40000 \times 1.75 = 70000 \) Rs.

(b) Quantity to be produced for getting 20000 profits, we have
\[ Q = \frac{F_c + \text{Profit}}{S_p - V_c} = \frac{30000 + 20000}{1.75 - 1} = \frac{50000}{0.75} = 66667 \text{ unit} \]

### 9.2 BEA Chart

The breakeven point could also be determined graphically if the output volume, fixed cost, variable cost and sales revenue all known. If BEA is done graphically it is called **BEP chart**. The breakeven chart consists, unit output in X-axis and cost and revenue expressed in rupees in Y-axis. The fixed cost line and variable cost line are drawn and total cost line is determined and drawn. A breakeven point is a point where revenue line total intersects total cost line. The loss and profit area can be determined as shown is graph.

![BEA Chart](image)

Though, the theory applied in breakeven chart is simple but it is very hard to obtain data to construct BE chart. The reason being that the line between fixed and variable cost is not definite. To construct an accurate breakeven chart from cost element, a great deal of prior work is required in order to establish the actual behavior of cost element in relation to volume. Good breakeven chart require excellent cost accounting system.

**Solved Example 2:**

From the following information calculate.

(a) Breakeven quantity.
(b) Breakeven sales value.
(c) Profit on producing 20% more and 30% less than BEP quantity.

**Information**

- Fixed cost = Rs. 30000
- Variable cost = Rs. 1 per unit
- Selling price = Rs. 1.75 per unit

**Solution:**

(a) **BEP (Quantity)**

\[ \text{BEP (Quantity)} = \frac{\text{Fixed cost}}{S_p - V_c} = \frac{30000}{1.75 - 1} = 40000 \text{ unit.} \]

(b) **BEP (Value)**

\[ \text{BEP (Value)} = \text{BEP unit} \times S_p = 40000 \times 1.75 = \text{Rs. 70000} \]

(c) **Profit on producing 20% more than BEP quantity**

\[ \text{Profit on producing 20\% more than BEP quantity} \]
Here, Quantity produce = 40000 + 20% of 40000 unit.
= 40000 + 8000
= 48000 unit

Now, profit = sales revenue of 48000 unit – (variable cost of 48000 unit + fixed cost)
= 48000 x 1.75 – (48000 x 1 + 30000)
= 84000 – 48000 = Rs. 6000

(d) Profit on producing 30% less than BEP quantity.
Here, Quantity produced is equal to
= 40000 – 30% of 40000 unit
= 28000 unit

Now, profit = 28000 x 1.75 – (28000 x 1 + 30000)
= 49000 – 58000
= – 9000 (loss)

From above calculation it is found that if quantity production is more than BEP unit, profit is obtained and if
production is less than BEP, loss is occured

The above information and calculation is shown on graph as follows:

Some time a word “Margin of safety” it’s used to express production above breakeven point. Here in example
48000 unit is produced where BEP volume is 40000 unit. This (48000 – 40000) i.e. 8000 unit is called “Margin of
safety”. If margin of safety is small and small drop in production capacity will reduce the profit considerably.

9.3.1 ASSUMPTION OF BEA

Breakeven analysis is based on the following assumption

(i) Variable cost charges directly and proportionately with the volume of output.
(ii) Fixed cost remains unchanged irrespective of the level of output.
(iii) Sales price is stable for multi product firm.
(iv) Product mix is stable for multi product firm.

9.3.2 ADVANTAGES AND APPLICATION OF BEA

Breakeven Analysis can be must helped in
(a) Budget planning.
(b) Evaluating new proposals and alternatives.
(c) Profit planning.
(a) Budget planning:
The detection of creep can be accelerated by applying BEA is budget planning and the overall soundness of a new budget can be tested as well. The approach under these circumstances would be through a breakeven chart, comparing breakeven point determined from flexible budget figure with the breakeven point of past operation and comparing budgeted profit with the profit that should be earned at the budgeted volume according to the breakeven and chart.

(b) Evaluating new proposals and alternatives:
Proposals to add or drop a product line, changes in selling price, changes in a manufacturing process, make or buy decisions or other similar course of actions should be first evaluated in terms of the effect on profits at expected operating levels. A secondary consideration, however, should be affected on the ‘cushion’ between expected operating levels and the breakeven points. Knowledge that a change will drastically reduce the cushion should receive careful consideration in determining whether such reduction is too great a price to pay for anticipated benefits.

(c) Profit planning:
CVP relationship revealed by BEP permit management to make policy decisions regarding output, cost price etc. It may adopt any one of the following strategies to achieve the planned level of profit.

1. Increases output
2. Reduce fixed cost.
3. Reduce variable cost.
4. Increase price.
5. Combination of any two or more of the above method.

Increases output
BEP analysis allows us to find out the production level for achieving desired profit. Let us examine the above example where fixed cost = Rs. 30000, variable cost is 1 per unit, selling price is 1.75 per unit and BEP found was 40000 unit, If the company want Rs. 40000 profit, the quantity to be produced is determined as follows:

\[ \text{Target quantity} = \frac{\text{Fixed cost + Targeted profit}}{\text{Selling price/unit - Variable cost/unit}} \]

\[ = \frac{30000 + 40000}{1.75 - 1} = \frac{70000}{0.75} = 93333 \text{ unit.} \]

Reduce fixed cost
A firm can also achieve planned profit by reducing its fixed cost of production while keeping its variable cost and price constant. E.g.: if the fixed cost is reduced to 25000

Then, \( \text{BEP (Unit)} = \frac{25000}{1.75 - 1} = 33333 \text{ unit.} \)

Here, for achieving desired profit of 40000 the quantity to be produced is given by.

\[ \text{Target quantity} = \frac{\text{Fixed cost + 40000}}{1.75 - 1} = 86666 \text{ unit} \]

i.e. by reducing fixed cost, the target profit 40000 is obtained by producing less quantity.

\[ = 93333 - 86666 = 6667 \text{ unit.} \]

Reduce variable cost
A firm can also achieve planned profit by reducing its variable cost of production, while keeping fixed cost and price constant. For example, if the variable cost is reduced to 0.75 the quantity to be produced for achieving 40000 units is given by

\[ \text{Target quantity} = \frac{30000 + 40000}{1.75 - 1} = 70000 \text{ unit} \]

Here, the target profit is obtained by producing \((93333 - 70000 = 23333)\) less than BEP product unit.

Increases selling price
The target can also be accomplished if the sell price is increased, keeping fixed cost, variable cost/unit are kept constant. Here, if the \( S_p \) is increased to Rs. 2, the target quantity is determined as
Target quantity = \frac{\text{Fixed cost} + \text{Targeted profit}}{\text{Selling price/unit} - \text{Variable cost/unit}}

= \frac{30000 + 40000}{2 - 1} = 70000

Here, the same profit is obtained in less production quantity by increasing the selling price.

Reduce variable cost and increase \( S_p \) or combination of other
Similarly the target profit could also be accomplished by combining any of the four formulations.

### 9.3.3 LIMITATIONS OF BEP

In spite of tremendous application of BEA on budgetary control and profit planning, the BEA has following limitations:

(i) In BEA, a constant sale price is assumed, which is practically impracticable in current market competition.

(ii) In BEA, a constant variable cost per unit is assumed. However, the variable cost is not constant rather it is \( \mathcal{V} \)-shaped. Variable cost rises up to certain point of production, then decline until they become minimum for certain production volume and they again start rising. Thus this change in variable cost cannot be applicable for this simple BEA. The non-linear BEA is developed to handle change in variable cost.

(iii) Sometime differentiation of fixed cost and variable cost is difficult, which makes BEA a meaning-less analysis.

(iv) BEA has the limited application in multi-product company. It can be used to find BEP for each product and also rank product in order of contribution margin but it does not indicate the optimum product mix. Management can however, use this technique for reducing aggregate BEP by giving a greater emphasis on product with higher contribution margin in preference to those with relatively lower contribution margin.

(v) BEA is essentially a short-run analysis because it is based on breakdown of costs of production between fixed and variable cost as in long run all costs are variable. Moreover BEA is static in nature and it is based on the historical cost. It is therefore, limited use for companies going through rapid change. However, BEA can be used in such cases on the basis of forecasts of production cost and sale price.