
UNIT 16 BREAK EVEN ANALYSIS

Structure

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16.0 OBJECTIVES

After studying this unit you should be able to:

- 1 understand the concept of break even analysis, impact of change in sales volume, price, variable cost, fixed costs on profits;
- 1 apply cost-volume profit relationship for profit planning;
- 1 understand the concept of margin of safety, angle of incidence, and profit volume ratio in decision making; and
- 1 examine the assumptions and limitations of the break even analysis

16.1 INTRODUCTION

In this unit you will learn about the concept of break-even point and finding out of break even point through mathematical equation and graphic representation. You will be acquainted with the relationship between Cost, Volume and Profit and its impact on planning and evaluation of business operations. You will also study the concepts of margin of safety, angle of incidence, limiting factor and profit volume ratio in decision making. The unit also deals with the underlying assumptions of break even analysis.

16.2 BREAK EVEN ANALYSIS

The analysis of cost behaviour is necessary for planning, control and decision making. Analysis of cost behaviour means analysis of variability of each cost element in relation to the level of output. Every cost follows some definite behaviour pattern. For example total variable costs varies in direct proportion to the volume of output but per unit variable cost remains same. Examples of such costs are direct material, direct labour, packaging expenses, selling commission etc. These costs are called product costs and are controllable, as they incur only when production takes place. Whereas fixed costs remains same irrespective to the level of output but per unit fixed cost goes on decreasing with the increasing level of output as fixed cost scattered over a large number of units. Examples of such expenses are rent, rates and insurance, executives' salary, audit fees etc. These costs are also called period costs and are uncontrollable. The mixed costs or semi-variable costs have both the elements variable and fixed. These costs also change in the same direction in which volume of output changes but this change is less than proportionate change in output. Examples of such costs are power, telephone, depreciation, etc. Thus the concept of break even analysis is a logical extension of marginal costing. It is based on the same principle of classifying the costs into fixed and variable.

Semi-variable costs are segregated in fixed and variable components as discussed in the earlier chapter. Fixed component is added in fixed costs and variable component with variable cost. Thus the costs are classified into two water tight compartments *i.e.* fixed and variable.

The cost behaviour play a significant role in decision making. The relationships in volume, cost and profit shows that if volume increase by 10 per cent (say), then cost will not increase by 10 per cent. Because only variable cost will increase and fixed costs remain same and unit fixed cost declines. Consequently, profit will not increase by 10 per cent but more than that and *vice versa*. The level of production changes due to many reasons, such as recession or boom, competition, introduction of new product, increase in demand, scarce raw material etc. The management wants to know the effect of these changes on profit. The break-even analysis helps the management in decision making in these situations.

The study of cost-volume-profit relationship is some time called as "break even analysis." In the opinion of some, it is a misnomer as break even analysis depicts a point where costs and total sales revenue is same. Beyond this point, it is called cost-volume-profit relationship. Some hold the view, that break even analysis can be interpreted in two senses – narrow and broad sense. In narrow sense, it refers to determine the level of output where total costs equal to total revenue *i.e.* no profit, no loss. In the broad sense, it is used to determine the probable profit at any level of output.

16.3 BREAK EVEN POINT

It is a point where sales revenue equals the costs to make and sell the product and no profit or loss is reported. In the words of Keller and Ferrara, "the break even point of a company or a unit of a company is the level of sales income which will equal to the sum of its fixed costs and variable costs." Charles T. Horngren define it, "the break even point is that point of activity (sales volume) where total revenues and total expenses are equal, it is the point of zero profit and zero loss."

There are two methods of calculating break even point. Mathematical method and Graphical method.

16.3.1 Mathematical Method

The break even point through mathematical method can be found out either by

- i) Equation Method, or
- ii) Contribution Margin Technique.

Equation Method

We know,

$$\text{Sales} - \text{Variable costs} - \text{Fixed cost} = \text{Profit} \quad (S - VC - FC = P)$$

$$\text{Sales} - \text{Variable costs} = \text{Fixed costs} + \text{Profit} \quad (S - VC = FC + P)$$

Sales minus variable costs is called Contribution. $(S - VC = C)$

$$\text{Contribution} = \text{Fixed costs} + \text{Profit} \quad (C = FC + P)$$

At break even point, profit is zero.

$$\therefore \text{Contribution} = \text{Fixed Costs (at break even point)}$$

or

$$(SP - VC) Q = F$$

Where, SP is selling price, VC is the variable costs, F is a fixed costs and Q is the number of units produced and sold. Look at the following illustration how the break-even point is to be calculated:

Illustration 1

Calculate the break even point from the following information :

Selling price	=	Rs. 3 per unit
Variable cost	=	Rs. 2 per unit
Fixed cost	=	Rs. 90,000
Estimated sales for the period	=	100,000 units or Rs. 300,000

Suppose the units to be produced and sold at break even point is Q, then

$$\text{Sales} - \text{Variable Costs} = \text{Contribution} = \text{Fixed Costs}$$

$$3 Q - 2 Q = 90,000$$

$$Q = 90,000 \text{ units}$$

When we produce and sell 90,000 units, then total sales revenue is Rs. 2,70,000 (90,000 units × Rs. 3) and total cost is Rs. 2,70,000, (VC Rs. 2 × 90000 units = 1,80,000 + F C Rs. 90,000)

Contribution Margins Technique

Contribution per unit means difference between selling price and variable costs
or

$$\text{Contribution per unit} = \text{Selling price per unit} - \text{Variable Cost per unit}$$

$$\text{Total Contribution} = \text{Sales Revenue} - \text{Total Variable Costs}$$

Break even point can be expressed in terms of units to be produced and sold or in terms of value of goods. At break even point, we know

Break Even Point in Units

Break Even Analysis

$$\text{Sales} - \text{Variable Costs} = \text{Fixed Costs}$$

or

$$(\text{SP} - \text{VC}) Q = \text{Fixed Costs}$$

or

$$Q = \text{BEP (in units)} = \frac{\text{Fixed Costs}}{\text{SP per unit} - \text{VC per unit}}$$

or

$$Q = \frac{\text{Fixed Costs}}{\text{Contribution Per Unit}}$$

Break Even Point in Value

Multiplying both sides by selling price (SP),

$$\text{SP} \times Q = \text{BEP (in value)} = \frac{\text{Fixed Cost} \times \text{SP per unit}}{\text{Contribution per unit}}$$

$$\text{or BEP (in value)} = \frac{\text{Fixed Costs} \times \text{Sales}}{\text{Total Sales} - \text{Total Variable Costs}}$$

$$\text{or} = \frac{\text{Fixed Costs} \times \text{Sales}}{\text{Total Contribution}}$$

Let us calculate the break-even point with the help of above equations by using the information given in illustration 1

$$\begin{aligned} \text{BEP (in units)} &= \frac{\text{Fixed Costs}}{\text{SP} - \text{VC}} \\ &= \frac{\text{Rs. } 90,000}{\text{Rs. } 3 - \text{Rs. } 2} = 90,000 \text{ units} \end{aligned}$$

$$\begin{aligned} \text{BEP (in value)} &= \frac{\text{Fixed Cost} \times \text{Selling Price}}{\text{SP} - \text{VC}} \\ &= \frac{\text{Fixed Costs} \times \text{Selling Price}}{\text{Contribution per unit}} \\ &= \frac{\text{Rs. } 90,000 \times \text{Rs. } 3}{\text{Rs. } 3 - \text{Rs. } 2} \\ &= \text{Rs. } 2,70,000 \end{aligned}$$

$$\begin{aligned} \text{BEP (in value)} &= \frac{\text{Fixed Costs} \times \text{Total Sales}}{\text{Total Sales} - \text{Variable Costs}} \\ &= \frac{\text{Rs. } 90,000 \times \text{Rs. } 300,000}{\text{Rs. } 300,000 - \text{Rs. } 200,000} = \text{Rs. } 2,70,000 \end{aligned}$$

It shows that a firm will be at a break even point when it is producing and selling 90,000 units or having a sale of Rs. 2,70,000.

Profit /Volume Ratio (P/V ratio)

Total contribution divided by total sales is called profit-volume ratio or contribution ratio (P/V ratio). Break-even point can be determined with the help of P/V ratio.

Cost Volume Profit Analysis

$$\begin{aligned} \text{P/V ratio} &= \frac{\text{Contribution}}{\text{Sales}} \\ &= \frac{\text{Sales} - \text{Variable Cost}}{\text{Sales}} \\ &= 1 - \frac{\text{Variable Cost}}{\text{Sales}} \end{aligned}$$

Or

$$\text{P/V Ratio} = \frac{\text{Fixed Cost} + \text{Profit}}{\text{Sales}} = \frac{F + P}{S}$$

$$\begin{aligned} \text{BEP (in value)} &= \frac{\text{Fixed Costs} \times \text{Total Sales}}{\text{Total Sales} - \text{Variable Costs}} \\ &= \frac{\text{Fixed Costs} \times \text{Total Sales}}{\text{Total Contribution}} \\ &= \frac{\text{Fixed Costs}}{\text{Total Contribution} \div \text{Total Sales}} \\ &= \frac{\text{Fixed Costs}}{\text{P/V Ratio}} \end{aligned}$$

Variable Costs to Sales is called Variable Cost Ratio.

$$\therefore \text{BEP (in value)} = \frac{\text{Fixed Costs}}{1 - \frac{\text{Variable Costs}}{\text{Sales}}}$$

It should be noted that firms producing one product line only, the calculation of break-even point is preferred in units and firms having a variety of product lines, calculation of break even point is preferred in value. P/V ratio can also be expressed in the form of percentage by multiplying by 100. Look at the following illustration.

Illustration 2

XYZ Ltd. is manufacturing and selling four types of products A, B, C and D. The sales mix and variable costs are as follows:

Product	Sales per month	Variable Cost Ratio
A	2,00,000	50%
B	1,50,000	50%
C	1,00,000	75%
D	2,50,000	40%

The fixed costs are Rs. 1,50,000 per month. Calculate break even point.

Solution

Firstly calculate the variable costs and contribution.

Particular	A	B	C	D	Total
Sales (Rs.)	2,00,000	1,50,000	1,00,000	2,50,000	7,00,000
Variable Costs (Rs.)	1,00,000	75,000	75,000	1,00,000	3,50,000
Contribution (Rs.)	1,00,000	75,000	25,000	1,50,000	3,50,000
Fixed Costs (Rs.)	-	-	-	-	1,50,000
Profit (Rs.)					2,00,000

$$\begin{aligned} \text{P/V Ratio} &= \frac{\text{Total Contribution}}{\text{Total Sales}} = \frac{\text{Rs. } 3,50,000}{\text{Rs. } 7,00,000} = 0.50 \text{ (i.e., 50\%)} \\ \text{Break Even Point (in value)} &= \frac{\text{Rs. } 1,50,000}{0.50} = \text{Rs. } 3,00,000 \\ \text{Variable Cost Ratio} &= \frac{\text{Variable Costs}}{\text{Total Costs}} = \frac{\text{Rs. } 3,50,000}{\text{Rs. } 7,00,000} = 0.50 \text{ (i.e., 50\%)} \\ \therefore \text{BEP (in value)} &= \frac{\text{Fixed Costs}}{1 - \frac{\text{Variable Costs}}{\text{Total Sales}}} = \frac{\text{Rs. } 1,50,000}{1 - 0.50} = \text{Rs. } 3,00,000 \end{aligned}$$

Break-even point as percentage of estimated capacity utilisation : Break-even point can also be calculated as a percentage of estimated sales or capacity utilisation by dividing the break-even sales by the estimated capacity sales/utilisation.

Illustration 3

The ratio of variable costs to sales is 70 percent. The break even point occurs at 60 percent of the capacity. Find the break even point sales when fixed costs are Rs. 90,000. Also compute profit at 75% of the capacity sales.

Solution

As the variable cost to sales ratio = 70%

We know

$$\begin{aligned} \text{P/V ratio or Contribution ratio} &= 1 - \frac{\text{VC}}{\text{Sales}} = 1 - 0.70 \\ &= 0.30 \\ \therefore \text{BEP (in value)} &= \frac{\text{Fixed Cost}}{\text{P/V Ratio}} = \frac{\text{Rs. } 90,000}{0.30} \\ &= \text{Rs. } 3,00,000 \end{aligned}$$

BEP occurs at 60 per cent of the capacity utilisation

Capacity Utilisation	Sales
60%	Rs. 3,00,000
75%	

We can apply unitary method or proportion method

$$X = \frac{\text{Rs. } 3,00,000 \times 75}{60} = \text{Rs. } 3,75,000$$

Now we can compute, contribution earned when sales is Rs. 3,75,000. Sales multiplied by P/V ratio gives the contribution.

$$\begin{aligned} \text{Contribution} &= \text{Sales} \times \text{P/V Ratio} \\ &= \text{Rs. } 3,75,000 \times 30\% \\ &= \text{Rs. } 1,12,500 \\ \therefore \text{Profit} &= \text{Contribution} - \text{Fixed Costs} \\ &= \text{Rs. } 1,12,500 - \text{Rs. } 90,000 \\ &= \text{Rs. } 22,500 \end{aligned}$$

16.3.2 Graphical Method

The break-even point can also be shown graphically. The BEP chart shows the relationships between cost, volume and profit at various levels of output. Fixed costs, variable costs and sales revenues are shown on Y-axis and volume of out on X-axis. The break-even point is that point at which the total cost line and total sales line intersect each other. This point represents “no profit, no loss”.

The following steps are involved in construction of break even chart:

- 1 Sales volume is plotted on x-axis. Sales volume may be expressed in terms of value (rupee), units or as percentage of capacity.
- 1 Cost and Revenue are depicted in y-axis. Fixed costs remains constant irrespective to the sales volume. Hence it is parallel to the x-axis and starts from Rs. 90,000. (Data of illustration 1) Variable cost starts from (0,0) because no sales volume, no variable cost and as the volume increases variable cost also increases. When a parallel line of variable cost drawn from the fixed cost line in y - axis, it depicts the total cost line. The sales revenue curve also starts from (0,0).
- 1 The point of intersection of sales revenue line and total cost line depicts, break even point. It occurs at a point of 90,000 units on x-axis and Rs. 2,70,000 (in terms of value) on y-axis.
- 1 The area to the left side of break even point depicts loss zone as cost curve is at a higher level and sale revenue line is at a lower level. The area to the right hand side of break even point is call profit zone as sale revenue line lies at a higher level than the total cost line.
- 1 The angle formed by the intersection of sale value line and total cost line is known as angle of incidence. Larger the angle, lower is the break even point and *vice versa*.

Let us draw a break even chart with the help of the following illustration.

Illustration 4

Let us draw a break-even chart with the help of data given below at different production levels of 0, 80,000, 90,000, 1,00,000 1,10,000, and 1,20,000 units.

Sale Price = Rs. 3 per unit

Variable Cost = Rs. 2 per unit

Fixed Cost = Rs. 90,000

Solution

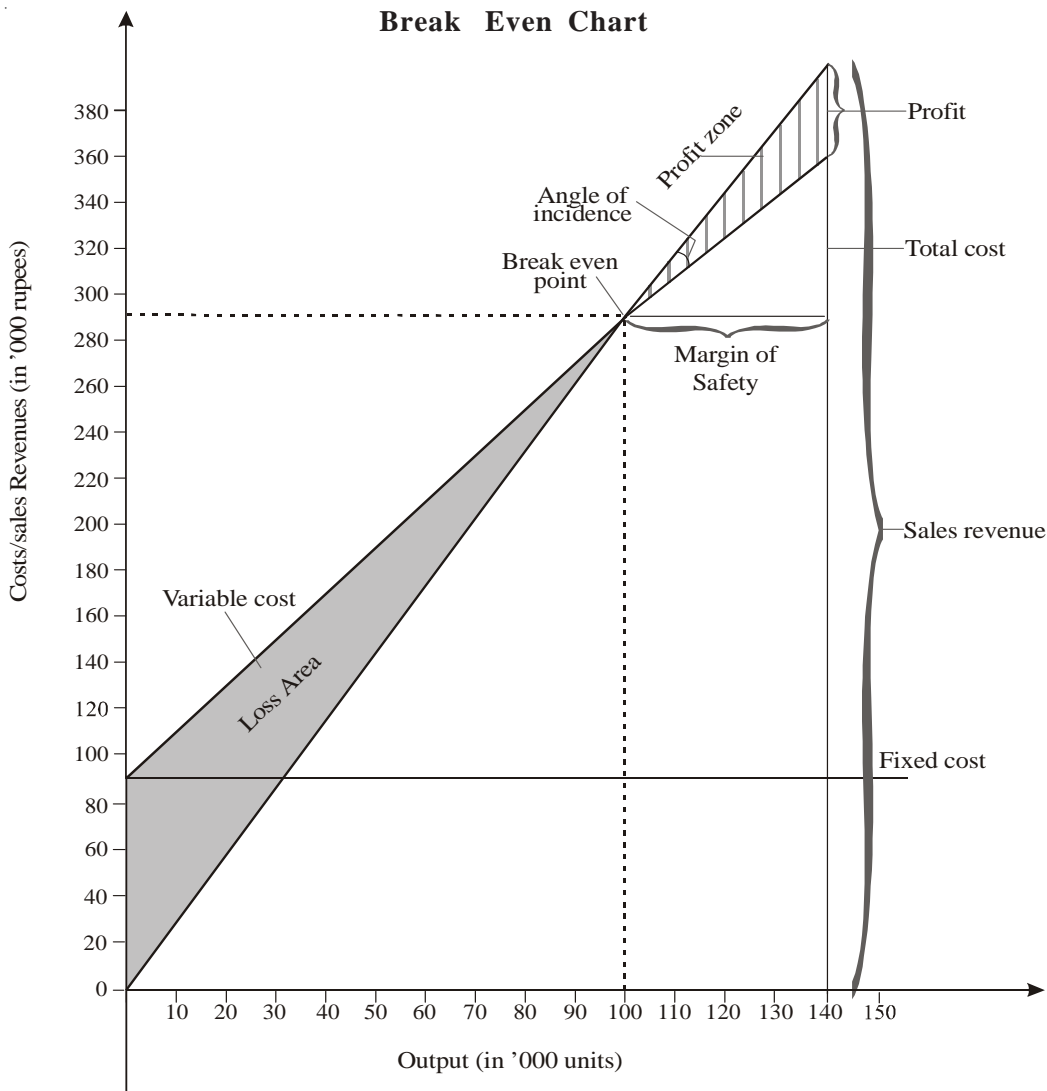
The costs and profits and different levels of output is computed as follows :

Output	Variable Cost Rs.	Fixed Cost Rs.	Total Cost Rs.	Sale Rev. Rs.	Profit Rs.
0	0	90,000	90,000	0	-90,000
80,000	1,60,000	90,000	2,50,000	2,40,000	-10,000
90,000	1,80,000	90,000	2,70,000	2,70,000	0
1,00,000	2,00,000	90,000	2,90,000	3,00,000	10,000
1,10,000	2,20,000	90,000	3,10,000	3,30,000	20,000
1,20,000	2,40,000	90,000	3,30,000	3,60,000	30,000

The above data if presented on a graph, it appears as follows :

Break Even Chart

Break Even Analysis



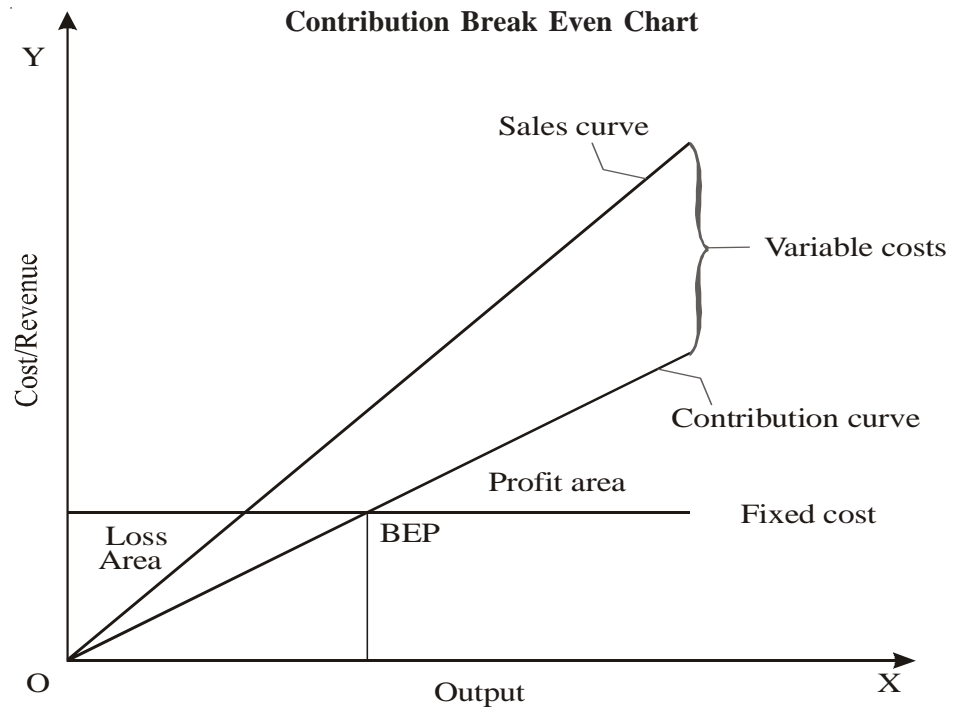
Contribution break even chart

From this chart we can ascertain the contribution earned at different levels of activity. Under this method, total cost line is not drawn instead the contribution line is drawn from the (0.0) point or origin. Intersection of cost line and sales line does not arise in this case as break even point occurs at where contribution is equal to fixed cost. When contribution is greater than fixed cost it is profit and vice versa. The contribution break even chart shows the contribution at different levels of activity and any level of activity below the BEP will not cover the fixed cost.

Let us represent the data as given in illustration 4 by means of contribution break-even Chart.

Solution :

Output	Variable Cost (Rs.)	Fixed Cost (Rs.)	Total Cost (Rs.)	Sale Rev. (Rs.)	Contribution (Rs.)
0	0	90,000	90,000	0	0
80,000	1,60,000	90,000	2,50,000	2,40,000	80,000
90,000	1,80,000	90,000	2,70,000	2,70,000	90,000
1,00,000	2,00,000	90,000	2,90,000	3,00,000	1,00,000
1,10,000	2,20,000	90,000	3,10,000	3,30,000	1,10,000
1,20,000	2,40,000	90,000	3,30,000	3,60,000	1,20,000



16.4 IMPACT OF CHANGES IN SALES PRICE, VOLUME, VARIABLE COSTS AND FIXED COSTS ON PROFITS

16.4.1 Impact of Sale Price Changes on Profit

Suppose the normal sales volume of X Y Z Ltd. is 1,00,000 units, selling at a price of Rs. 3 per unit. The variable cost is Rs. 2 per unit, fixed cost is Rs. 90,000. The capital investment is Rs. 1,00,000. Let us study the impact of change in price on profit under two conditions i.e. increase in price by 5 per cent and 10 per cent and decrease in price by 5 per cent and 10 per cent.

Impact of Change in Sales Prices on Profit

Sl. No.	Particulars	Decrease in Price		Normal Volume	Increase in Price	
		10%	5%		5%	10%
1.	Outputs (units)	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000
2.	Sales (Rs.)	2,70,000	2,85,000	3,00,000	3,15,000	3,30,000
3.	Variable Costs (Rs.)	2,00,000	2,00,000	2,00,000	2,00,000	2,00,000
4.	Marginal Income or Contribution (2-3) (Rs.)	70,000	85,000	1,00,000	1,15,000	1,30,000
5.	Fixed Costs (Rs.)	90,000	90,000	90,000	90,000	90,000
6.	Operating Profit / Loss (4-5) (Rs.)	-20,000	-5,000	10,000	25,000	40,000
7.	% Change in Profit	-300%	-150%	—	150%	300%
8.	Break even point (units)	1,28,571	1,05,882	90,000	78,261	69,231
9.	P/V Ratio	0.2592	0.2982	0.3333	0.3651	0.3939
10.	Return on Investment %	-20%	-5%	10.00	25.00	40.00

From the above table, we can draw the following inferences:

- 1) A small change in price brings wide fluctuations in **operating profit**. For example 5 per cent decrease in price brings 150 per cent decrease in profit and *vice versa*. The change is 30 times.

The change can be computed as follows:

$$= \frac{\% \text{ Change in Profit}}{\% \text{ Change in Price}}$$

When price declines by 5 percent, then change in profit is

$$= \frac{150\%}{5\%} = 30 \text{ times}$$

There is an inverse relationship in change in price and change in break even point. When price increase other factors remains same, the break-even point declines.

Increase in sale price leads to higher contribution resulting in lower break even point and *vice versa*. A lower number of units have to be sold in order to recover the fixed cost.

- 2) **Profit-Volume Ratio:** There is a direct relationship in change in price and change in profit volume ratio. With change in price, the contribution also changes consequently P/V ratio also changes.
- 3) **Return of Investment:** Like in operating profits, the change in price has a magnified impact on return on investment.

16.4.2 Impact of Volume Changes on Profit

Let us study the impact of change in volume on profit in the above-mentioned example.

Sl. No.	Particulars	Decrease in Price		Normal Volume	Increase in Price	
		10%	5%		5%	10%
1.	Outputs (units)	80,000	90,000	1,00,000	1,10,000	1,20,000
2.	Sales (Rs.)	2,40,000	2,70,000	3,00,000	3,30,000	3,60,000
3.	Variable Costs (Rs.)	1,60,000	1,80,000	2,00,000	2,20,000	2,40,000
4.	Contribution (Rs.) (2-3)	80,000	90,000	1,00,000	1,10,000	1,20,000
5.	Fixed Costs (Rs.)	90,000	90,000	90,000	90,000	90,000
6.	Operating Profit (4-5) (Rs.)	- 10,000	0	10,000	20,000	30,000
7.	% Change in Profit	-200	-100	-	100	200
8.	Break even point (units)	90,000	90,000	90,000	90,000	90,000
9.	P/V Ratio or Percentage	0.3333 or 33.33%	0.3333 or 33.33%	0.3333 or 33.33%	0.3333 or 33.33%	0.3333 or 33.33%
10.	Return on Investment (%)	-10.00	0	10.00	20.00	30.00

From above table, the following inferences can be drawn:

- 1) **Percentage Change in Profit:** A small change in sales volume brings a wide fluctuation in profit. For example, a 10 per cent change in sales volume leads to a 100 per cent change in profit. It is called operating leverage or operating elasticity. Mathematically, it is

$$\text{OL or OE} = \frac{\% \text{ Change in Profit}}{\% \text{ Change in Sales}}$$

The operating leverage or operating elasticity is the degree of responsiveness or sensitivity of operating profit to change in sales. In the above example, operating leverage or operating elasticity is

$$\text{OL or OE} = \frac{\% \text{ Change in Profit}}{\% \text{ Change in Sales}} = \frac{100\%}{10\%} = 10 \text{ times}$$

It depicts that 1 percent change in sales leads to 10 times change in operating profit *i.e.* 10 per cent.

- 2) **Break Even Point:** There is no impact on the break-even point. Because contribution per unit (Sale Price – Variable Costs) and fixed costs are not influenced by the change in volume. Thus break even point is unaffected when there is a change in sales volume.
- 3) **P/V Ratio:** Like break even point, there is no impact on profit volume ratio as contribution per unit and sale price per unit is same as at normal level.
- 4) **Return on Investment:** Like in operating profit, the impact of change in sale volume has a magnified impact on return on investment.

16.4.3 Impact of Change in Price and Volume on Profit

Sl. No.	Particulars	Decrease in Price		Normal Volume	Increase in Price	
		10%	5%		5%	10%
		Increase in Volume			Decrease in Volume	
		20%	10%		10%	20%
1.	Outputs (units)	1,20,000	1,10,000	1,00,000	90,000	80,000
2.	Sales (Rs.)	3,24,000	3,13,500	3,00,000	2,83,500	2,64,000
3.	Variable Costs (Rs.)	2,40,000	2,20,000	2,00,000	1,80,000	1,60,000
4.	Contribution (3-2)	84,000	93,500	1,00,000	1,03,500	1,04,000
5.	Fixed Costs (Rs.)	90,000	90,000	90,000	90,000	90,000
6.	Operating Profit	-6,000	3,500	10,000	13,500	14,000
7.	% Change in Profit	-160.00	-65.00	-	35.00	40.00
8.	Break even point (units)	1,28,571	1,05,882	90,000	78,261	69,231
9.	P/V Ratio	0.2592	0.2982	0.3333	0.3651	0.3939
	Percentage	25.92	29.82	33.33	36.51	39.39
10.	Return on Investment (%)	6.00	3.5	10.00	13.50	40.00

Activity: 1 Try to draw the inferences from the above table and also prepare the similar tables for increasing and decreasing the fixed costs and variable cost and study the impact on profit, break even profit, P/V ratio etc.

16.5 REQUIRED SALES FOR DESIRED PROFIT

Break even point equation can be extended to estimate the profit and loss at different levels of production. At break even point, profit is zero but for calculating the sales volume required to earn a desired profit, the profit value is put as desired profit. The following equations can be derived for this purpose.

$$\begin{aligned} \text{Sales} - \text{Variable Costs} &= \text{Fixed Costs} + \text{Desired Profit} \\ \text{or} \\ \text{Contribution} &= \text{Fixed Costs} + \text{Desired Profit} \end{aligned}$$

$$\begin{aligned} \text{Sales Volume Required (in Units)} &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{SP} - \text{VC (Per unit)}} \\ &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{Contribution Per Unit}} \end{aligned}$$

$$\begin{aligned} \text{Sales Volume Required (in Value)} &= \frac{(\text{Fixed Cost} + \text{Desired Profit}) \text{ Sales}}{\text{Sales} - \text{Variable Costs}} \\ &= \frac{(\text{Fixed Cost} + \text{Desired Profit}) \text{ Sales}}{\text{Total Contribution}} \\ &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{P/V Ratio}} \\ &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{1 - \text{Variable Costs/Sales}} \end{aligned}$$

Illustration 5

A company producing a single product and sells it at Rs. 10 per unit. Variable cost is Rs. 6 per unit and fixed cost is Rs. 40,000 per annum. Calculate (a) Break even point, (b) Sales volume required to earn a profit of Rs. 60,000 per annum

Solution

$$\begin{aligned} \text{Contribution} &= \text{SP} - \text{VC} = \text{Rs. } 10 - \text{Rs. } 6 \\ &= \text{Rs. } 4 \text{ per unit} \end{aligned}$$

$$\begin{aligned} \text{BEP (in units)} &= \frac{\text{Fixed Costs}}{\text{Contribution Per Unit}} \\ &= \frac{\text{Rs. } 40,000}{\text{Rs. } 4} = 10,000 \text{ units} \end{aligned}$$

$$\text{BEP (in value)} = \frac{\text{Fixed Costs}}{\text{P/V Ratio}}$$

$$\begin{aligned} \text{P/V Ratio} &= \frac{\text{Total Contribution}}{\text{Total Sales}} \\ &= \frac{\text{Rs. } 40,000}{\text{Rs. } 1,00,000} = 0.40 \end{aligned}$$

$$\begin{aligned} \text{BEP} &= \frac{\text{Rs. } 40,000}{0.40} \\ &= \text{Rs. } 1,00,000 \end{aligned}$$

Cost Volume Profit Analysis

$$\begin{aligned} \text{Sales volume required to} &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{Contribution Per Unit}} \\ \text{earn a desired profit (in units)} &= \frac{\text{Rs. 40,000} + \text{Rs. 60,000}}{\text{Rs. 4}} \\ &= \frac{\text{Rs. 1,00,000}}{\text{Rs. 4}} = 25,000 \text{ units} \end{aligned}$$

$$\begin{aligned} \text{Sales volume required to} &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{P/V Ratio}} \\ \text{earn desired profit (in value)} &= \frac{\text{Rs. 40,000} + \text{Rs. 60,000}}{0.40} = \text{Rs. 2,50,000} \end{aligned}$$

16.6 SALES VOLUME REQUIRED TO EARN A DESIRED PROFIT PER UNIT

If we add the desired profit per unit with variable cost and apply the same equations, the result will provide us the sales volume required to earn a desired profit per unit.

In Units

$$\begin{aligned} \text{Sales Volume Required} &= \frac{\text{Fixed Cost}}{\text{SP} - (\text{VC} + \text{DP})} \\ \text{(in units)} & \end{aligned}$$

Where DP is desired profit per unit

In Value

$$\begin{aligned} \text{Sales Volume Required} &= \frac{\text{Fixed Cost}}{\text{VC} + \text{P}} \\ \text{(in value)} & 1 - \frac{\text{Selling Price}}{\text{Selling Price}} \\ &= \frac{\text{Fixed Cost}}{\text{(VC} + \text{Desired Percentage of Profit on Sales)}} \\ & 1 - \frac{\text{SP}}{\text{SP}} \end{aligned}$$

Illustration 6

The cost information computed by the cost accountant is as follows :

Sales	=	1,00,000 units
Selling Price	=	Rs. 10 per unit
Variable cost or out of pocket-costs	=	Rs. 6 per unit
Fixed costs or burden	=	Rs. 60,000 per annum

Compute the following :

- Break even points in units and value
- Make a profit of Rs. 40,000
- Make a profit of Rs. 2 per unit
- Make a profit of 30% on sales

Solution**Break Even Analysis**a) **Break Even Point (in units)**

$$\begin{aligned} \text{Contribution per unit} &= \text{SP} - \text{VC} \\ &= \text{Rs.10} - \text{Rs. 6} = \text{Rs. 4 per unit} \\ \text{BEP in units} &= \frac{\text{Fixed Costs}}{\text{Contribution per unit}} \\ &= \frac{\text{Rs. 60,000}}{\text{Rs. 4}} = 15,000 \text{ units} \end{aligned}$$

In Value

$$\begin{aligned} \text{P/V or Contribution Ratio} &= \frac{\text{SP} - \text{VC}}{\text{SP}} \\ &= \frac{\text{Rs. 10} - \text{Rs. 6}}{\text{Rs. 10}} = 0.40 \\ \text{BEP in value} &= \frac{\text{Fixed Costs}}{\text{P/V Ratio}} \\ &= \frac{\text{Rs. 60,000}}{0.40} = \text{Rs. 1,50,000} \end{aligned}$$

b) **Sales volume required to earn a profit of Rs. 40,000****In units**

$$\begin{aligned} &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{Contribution per unit}} \\ &= \frac{\text{Rs. 60,000} + \text{Rs. 40,000}}{\text{Rs. 4}} = 25,000 \text{ units} \end{aligned}$$

In Value

$$\begin{aligned} &= \frac{\text{Fixed Costs} + \text{Desired Profit}}{\text{P/V Ratio}} \\ &= \frac{\text{Rs. 60,000} + \text{Rs. 40,000}}{0.40} = \text{Rs. 2,50,000} \end{aligned}$$

c) **Sales volume required to earn a profit of Rs. 2 per unit****In Unit**

$$\begin{aligned} &= \frac{\text{Fixed Costs}}{\text{SP} - (\text{VC} + \text{P})} \\ &= \frac{60,000}{\text{Rs. 10} - (\text{Rs. 6} + \text{Rs. 2})} = 30,000 \text{ units} \end{aligned}$$

In Value

$$\begin{aligned} &= \frac{\text{Fixed Costs}}{1 - (\text{VC} + \text{PD})/\text{SP}} \\ &= \frac{60,000}{1 - (6+2) / 10} \\ &= \frac{60,000}{2/10} = \text{Rs. 3,00,000} \end{aligned}$$

d) Sales volume required to earn a profit of 30% on sales

$$\begin{aligned} \text{In unit} &= \frac{\text{Fixed Cost}}{\text{SP} - (\text{VC} + 30\% \text{ of SP})} \\ &= \frac{\text{Rs. } 60,000}{\text{Rs. } 10 - (6+3)} = 60,000 \text{ units} \end{aligned}$$

In Value

$$\begin{aligned} &= \frac{\text{Fixed Costs}}{1 - (\text{VC} + 30\% \text{ of SP}) / \text{SP}} \\ &= \frac{60,000}{1 - (6+3) / 10} = \text{Rs. } 6,00,000 \end{aligned}$$

Calculations of selling price per unit for a particular break even point.

We know

$$\text{BEP Units} = \frac{\text{Fixed Costs}}{\text{Contribution Per Unit}}$$

$$\therefore \text{Contribution per unit} = \frac{\text{Fixed Costs}}{\text{BEP Units}}$$

Selling price per unit – Variable cost per unit = Contribution per unit

∴ Selling price per unit = Contribution per unit + Variable Cost per unit

Thus

$$\text{Selling Price per unit} = \frac{\text{Fixed Costs}}{\text{Desired BEP}} + \text{Variable Cost}$$

Illustration 7

$$\text{Given Fixed Costs} = \text{Rs. } 40,000$$

$$\text{Selling Price Per Unit} = \text{Rs. } 40$$

$$\text{Variable Cost} = \text{Rs. } 30$$

The break-even point in this case is

$$\begin{aligned} \text{BEP Units} &= \frac{\text{Rs. } 40,000}{\text{Rs. } 40 - \text{Rs. } 30} = \frac{\text{Rs. } 40,000}{\text{Rs. } 10} \\ &= 4000 \text{ units} \end{aligned}$$

What should be selling price per unit, if management wants to reduce the break-even point from 4000 units to 2500 units?

Solution

$$\begin{aligned} \text{Selling price per unit} &= \frac{\text{Fixed Costs}}{\text{Desired B E P}} + \text{VC} \\ &= \frac{\text{Rs. } 40,000}{2500 \text{ units}} + \text{Rs. } 30 \\ &= \text{Rs. } 16 + \text{Rs. } 30 = \text{Rs. } 46 \text{ per unit} \end{aligned}$$

16.7 SALES REQUIRED TO MAINTAIN PRESENT PROFIT

Calculating the sales volume required to meet the proposed expenditure

Because of high competition in the market, the management plans an aggressive promotion policy to boost the sales, which requires an extra expenditure. In such cases, management wants to know the additional sales volume required to cover the expected increase in expenditure.

Here the logic should be to cover the extra expenditure, how much additional units to be sold. Suppose contribution per unit is Rs. 10 per unit and a company spends Rs. 1,00,000 extra on advertisement, then logically company must sell 10,000 extra units to cover this expenditure. Thus the formula should be

In units

$$\text{Additional Sales Volume Required} = \frac{\text{Proposed Expenditure}}{\text{Contribution per unit}}$$

In value

$$\text{Additional Sales Volume Required} = \frac{\text{Proposed Expenditure}}{\text{P/V Ratio}}$$

Illustration 8

Sales	10,000 units
Fixed Cost	Rs. 1,00,000
Variable Cost	Rs. 2,00,000

The selling price is Rs. 36 per unit. The company is spending Rs. 100,000 on advertisement to promote its product. Find the sale volume required to earn the present profit.

Solution

Extra sales volume required to meet the additional publicity expenditure of Rs. 1,00,000 so as to maintain the present profit level is worked out as follows:

$$\text{Variable Cost Per Unit} = \frac{\text{Rs. 2,00,000}}{10,000 \text{ units}} = \text{Rs. 20 per unit}$$

$$\text{Contribution Margin} = \text{Rs. 36} - \text{Rs. 20} = \text{Rs. 16 per unit}$$

$$\text{Addition sales required (in units)} = \frac{\text{Rs. 1,00,000}}{\text{Rs. 16}} = 6,250 \text{ units}$$

When a company sells 6,250 unit extra, then present level of profit will be maintained. For example, before spending money the company was earning a profit of Rs. 60,000 which is as follows:

$$\begin{aligned} \text{Profit} &= \text{Contribution} - \text{Fixed Cost} \\ &= \text{Rs. 16} \times 10,000 - \text{Rs. 1,00,000} \\ &= \text{Rs. 1,60,000} - \text{Rs. 1,00,000} = \text{Rs. 60,000} \end{aligned}$$

When sales volume increase to 16,250 units (i.e. 10,000 units + 6,250) then profit will be

$$\begin{aligned} &= \text{Rs. 16} \times 16,250 - \text{Rs. 2,00,000} \text{ (F. C. Rs. 1,00,000 + Advertisement Rs. 1,00,000)} \\ &= \text{Rs. 2,60,000} - \text{Rs. 2,00,000} = \text{Rs. 60,000} \end{aligned}$$

Calculating the sales volume required to offset price reduction

Some time management wants to follow the policy of price reduction or increasing commission to dealers for increasing the sales or to face the competition. In these case new values are used for calculations and formula remains the same.

Illustration 9

ABC Ltd. manufactured and markets a product whose cost data is as follows:

Material Costs	=	Rs. 16 per unit
Conversion (Variable Cost)	=	Rs. 12 per unit
Dealer's Margin	=	Rs. 4 per unit (10% of selling price)
Selling Price	=	Rs. 40 per unit
Fixed Cost	=	Rs. 5,00,000
Present Sales	=	90,000 units
Capacity Utilisation	=	60%

Management has following two suggestions, which alternative is better so as to maintain the present profit level?

- Reduction in Selling Price by 5%
- Increasing the dealer's margin by 25% over the existing rates

Solution

Total variable costs	=	Rs. 16 + Rs.12 + Rs. 4	=	Rs. 32 per unit
Contribution per unit	=	Rs. 40 – Rs. 32	=	Rs. 8 per unit
Present Profit Level	=	Rs. 8 × Rs. 90,000 – Rs. 5,00,000	=	Rs. 2,20,000

- First alternative** : Price reduction by 5%

New selling price	=	(Rs. 40 – Rs.2)	=	Rs. 38 per unit
New Dealer's Commission	=	10% of Rs. 38	=	Rs. 3.80
New Contribution	=	Rs. 38 – (Rs. 16 + Rs. 12 + Rs. 3.80)	=	Rs. 6.20 per unit

Sales volume requires to earn a desired profit (in units)

$$= \frac{FC + DP}{\text{Contribution per unit}}$$

$$\text{Sales volume Required (in units)} = \frac{\text{Rs. 5,00,000} + \text{Rs. 2,20,000}}{\text{Rs. 6.20}}$$

$$= \frac{\text{Rs. 7,20,000}}{\text{Rs. 6.20}} = 1,16,129 \text{ units}$$

- Second Alternative** : Increasing dealer's commission by 25%

New Dealer's Commission	=	Rs. 4+25% of Rs. 4	=	Rs. 5 per unit
New Contribution	=	Rs. 40 – (Rs. 16 + Rs. 12 + Rs. 5)	=	Rs. 7 per unit
Sales required (in units)	=	$\frac{\text{Rs. 5,00,000} + \text{Rs. 2,20,000}}{\text{Rs. 7}}$	=	1,02,857 units

In the second alternative, lesser units are required to be sold as compared to the first alternative. Contribution margin is also high in second alternative. Hence second alternative is better in comparison to the first alternative.

Calculating new sales volume or new selling price to offset the impact of change in variable costs and fixed costs.

When a company introduces new production plans or improve the process, then generally variable costs and fixed costs also change. In such situation, there are two alternatives before the management to earn the same profits either to increase the sales volume or increase the selling price when costs increases and vice versa. The new sales volume needed to earn the same profit, when only variable costs changes, then new contribution is calculated by changing the variable cost and break even equation remains same. If management wants to change the selling price and volume remains the same, then new selling price is :

New selling price = Old selling price + (new variable cost — old variable cost)

When fixed cost changes, then fixed costs is replaced by a new fixed cost in the equation and new volume of sales can be computed to earn the same profit. If management thinks that selling price be changed and volume remain the same, then new selling price is :

New selling price = Old selling + $\frac{\text{New fixed cost — old fixed costs}}{\text{Volume of production}}$

The logic is change in selling price is incremental change in variable cost and / or fixed cost per unit is added in selling price so as to earn the same profit. Look at the following illustration how the new selling price is calculated when there is change in variable and fixed costs :

Illustration 10

The cost information supplied by the cost accountant is as follows:

Sales 20,00 units @ Rs. 10 per unit	Rs. 2,00,000
Variable cost Rs. 6 per unit	Rs. 1,20,000
Contribution	Rs. 80,000
Fixed Cost	Rs. 30,000
Profit	Rs. 50,000

Calculate the (a) new sales quantity and (b) new selling price to earn the same profit if

- Variable cost increases by Rs. 2 per unit
- Fixed cost increase by Rs. 10,000
- Variable cost increase by Rs. 1 per unit and fixed cost reduces by Rs. 10,000

Solution

- Variable cost increases by Rs. 2

$$\text{a) New sales quantity required} = \frac{F + DP}{SP - V_n}$$

where V_n is the new variable cost

$$= \frac{\text{Rs. 30,000} + \text{Rs. 50,000}}{\text{Rs.10} - \text{Rs.8}} = \frac{\text{Rs. 80,000}}{\text{Rs.2}} = 40,000 \text{ units}$$

Cost Volume Profit Analysis

b) New selling price

$$= \text{Old selling price} + \text{change in variable cost per unit}$$

$$= \text{Rs. } 10 + \text{Rs. } 2 = \text{Rs. } 12 \text{ per unit}$$

To earn the same amount of profit, management should either increase the production to 40,000 units or increase the selling price to Rs. 12 per unit

ii) Fixed costs increases by Rs. 10,000

a) Sales volume needed to earn a desired profit

$$= \frac{F_n + DP}{SP - VC}$$

F_n is the new fixed costs

$$= \frac{\text{Rs. } 40,000 + \text{Rs. } 50,000}{\text{Rs. } 10 - \text{Rs. } 6} = 22,500 \text{ units}$$

b) New selling price

$$= SP_o + \frac{F_n - F_o}{Q}$$

SP_o is old selling price, F_n is new fixed cost and F_o is old fixed cost.

$$= 10 + \frac{\text{Rs. } 40,000 - \text{Rs. } 30,000}{20,000 \text{ units}} = \text{Rs. } 10.50$$

To earn the same amount of profit i.e. Rs. 50,000 management should either increase the sales volume to 22,500 units or increase the selling price to Rs. 10.50.

iii) Variable cost increase by Rs. 1 per unit and fixed cost reduces by Rs. 10,000.

a) Sales volume required to earn a desired profit

$$= \frac{F_n + DP}{SP - V_n}$$

$$= \frac{\text{Rs. } 20,000 + \text{Rs. } 50,000}{\text{Rs. } 10 - \text{Rs. } 7} = \frac{\text{Rs. } 70,000}{\text{Rs. } 3} = 23,333 \text{ units}$$

b) New Selling price

$$= SP_o + \frac{(VC_n - VC_o)}{Q} + F_n - F_o$$

$$= \text{Rs. } 10 + \frac{\text{Rs. } 20,000 - \text{Rs. } 30,000}{20,000 \text{ units}} + \text{Rs. } 7 - \text{Rs. } 6$$

$$= \text{Rs. } 10 - \text{Rs. } 0.50 + \text{Rs. } 1$$

$$= \text{Rs. } 10.50$$

To earn the same profit i.e. Rs. 50,000 management should either increase the sales to 23,333 units or increase the selling price to Rs. 10.50.

Illustration 11

The cost data of XYZ Ltd. is as follows:

	Product X	Product Y	Product Z	Total Rs.
Sales (40 : 50 : 10) (Rs.)	80,000	1,00,000	20,000	2,00,000
Variable Costs (Rs.)	50,000	60,000	10,000	1,20,000
Contribution (Rs.)	30,000	40,000	10,000	80,000
Fixed (Rs.)	—	—	—	50,000
Profit	—	—	—	30,000

Calculate :

- Break Even Point, and
- Break even point if sales mix ratio is changed to 30:50:20

Solution**i) Break Even Point**

When company is producing multi products, then for computing break even equation in terms of value should be used.

$$\begin{aligned}
 \text{BEP (in value)} &= \frac{\text{Fixed Costs} \times \text{Total Sales}}{\text{Total Sales} - \text{Variable costs}} \\
 &= \frac{\text{Rs. } 50,000 \times \text{Rs. } 2,00,000}{\text{Rs. } 2,00,000 - \text{Rs. } 1,20,000} \\
 &= \frac{\text{Rs. } 50,000 \times \text{Rs. } 2,00,000}{\text{Rs. } 80,000} = \text{Rs. } 1,25,000
 \end{aligned}$$

ii) Change in Sales Mix Ratio

New Sales mix X : Y : Z = 30:50:20

Sales

$$X = \text{Rs. } 2,00,000 \times \frac{30}{100} = \text{Rs. } 60,000$$

$$Y = \text{Rs. } 2,00,000 \times \frac{50}{100} = \text{Rs. } 1,00,000$$

$$Z = \text{Rs. } 2,00,000 \times \frac{20}{100} = \text{Rs. } 40,000$$

Variable Cost Ratio (as variable cost per unit remains same)

$$X = \frac{\text{Rs. } 50,000}{\text{Rs. } 80,000} = \frac{5}{8}$$

$$Y = \frac{\text{Rs. } 60,000}{\text{Rs. } 1,00,000} = \frac{6}{10}$$

$$Z = \frac{\text{Rs. } 10,000}{\text{Rs. } 20,000} = \frac{1}{2}$$

Cost Volume Profit Analysis

	X	Y	Z	Total Rs.
Sales (Rs.)	60,000	1,00,000	40,000	2,00,000
Variable Costs (Rs.)	37,500	60,000	20,000	1,17,500
Contribution (Rs.)	22,500	40,000	20,000	82,500
Fixed Costs	—	—	—	50,000
Profit	—	—	—	32,500

Break even point after change in sales mix

$$= \frac{\text{Fixed Costs} \times \text{Sales}}{\text{Sales} - \text{Variable Costs}}$$

$$= \frac{\text{Rs. } 50,000 \times \text{Rs. } 2,00,000}{\text{Rs. } 2,00,000 - \text{Rs. } 1,17,500} = \frac{\text{Rs. } 50,000 \times \text{Rs. } 2,00,000}{\text{Rs. } 82,500}$$

$$= \text{Rs. } 1,21,212.12$$

Illustration 12

A firm produces and sells three products A, B and C. From the following data, calculated the break even point.

Product	No. of Units Sold	SP per unit Rs.	VC per unit Rs.
A	600	50	30
B	1500	60	45
C	1000	30	15

Fixed costs are Rs. 33,000 per year.

Solution

Firstly we calculate the over all P/V ratio which is :

$$= \frac{\text{SP} - \text{VC}}{\text{SP}} \text{ or } 1 - \frac{\text{VC}}{\text{SP}}$$

Product	SP (Rs.)	VC (Rs.)	P/V Ratio	Total Sales (Rs.)	%Sale Proceeds	Overall P/V Ratio
A	50	30	0.40	30,000	0.20	0.08
B	60	45	0.25	90,00	0.60	0.15
C	30	15	0.50	30,000	0.20	0.10
				Rs. 1,50,000	1.00	0.33

The overall P/V ratio is 0.33 (P/V Ratio × % sales proceeds). P/V ratio can also be computed as per preceding illustration.

$$\therefore \text{Overall Break Even Point} = \frac{\text{Fixed Costs}}{\text{P/V ratio}}$$

$$= \frac{\text{Rs. } 33000}{0.33}$$

$$= \text{Rs. } 1,00,000$$

The break up of total sales at Break Even Point will be:

	% Sales Proceeds	Sales proceeds	No. of Units
A	0.20	Rs. 20,000	400
B	0.60	Rs. 60,000	1000
C	0.20	Rs. 20,000	667
		<u>Rs. 1,00,000</u>	

16.8 MARGIN OF SAFETY

The margin of safety is the difference between actual sales and sales at break even point.

$$M/S = \text{Actual Sales} - \text{Sales at BEP}$$

Suppose the actual sales of X Y Z Ltd. (example given in 16.3) is 1,20,000 units and sales at break even point is 90,000 units, then

$$M/S = 1,20,000 \text{ units} - 90,000 \text{ units} = 30,000 \text{ units}$$

Sale price was Rs. 3 per unit.

$$M/S = \text{Rs. } 3,60,000 - \text{Rs. } 2,70,000 = \text{Rs. } 90,000$$

It can be expressed in terms of Rupees or in units, and is a absolute measure. It can be expressed in relative terms and is

$$\begin{aligned} M/S &= \frac{\text{Actual Sales} - \text{Sales at Break Even Points}}{\text{Actual Sales}} \times 100 \\ &= \frac{\text{Rs. } 1,20,000 - \text{Rs. } 90,000}{\text{Rs. } 1,20,000} \times 100 = \frac{30,000}{1,20,000} \times 100 = 25\% \end{aligned}$$

If we use the sales data in terms of rupees and compute the relative margin of safety, the answer will remain the same, for example

$$\begin{aligned} M/S &= \frac{\text{Rs. } 3,60,000 - \text{Rs. } 2,70,000}{\text{Rs. } 3,60,000} \times 100 \\ &= \frac{\text{Rs. } 90,000}{\text{Rs. } 3,60,000} \times 100 = 25\% \end{aligned}$$

Margin of safety can also be computed from profit and P/V ratio, which is

$$M/S = \frac{\text{Profit}}{\text{P/V Ratio}}$$

Higher margin of safety provides greater protection to the company. The size of margin of safety is an indicator of soundness of business. It shows how much sales may decrease before the firm will suffer a loss. Sales beyond the break-even point represent margin of safety. Larger the margin of safety, greater the soundness of the business, smaller the margin of safety, weaker will be the soundness of the business. The following actions help in improving the margin of safety:

- 1) Increase the level of production
- 2) Reduce the fixed and / or variable costs
- 3) Increase the selling price
- 4) Substitute the existing product with more profitable products
- 5) From the product mix, remove the product whose contribution ratio is very low

Illustration 13

Calculate the P/V ratio, fixed expenses and break even point from the following data:

Sales	Rs. 6,00,000
Profit	Rs. 40,000
Margin of safety	Rs. 1,60,000

Solution

We know

$$M/S = \frac{\text{Profit}}{\text{P/V ratio}}$$

$$\begin{aligned} \text{P/V Ratio} &= \frac{\text{Profit}}{\text{M/S}} \\ &= \frac{\text{Rs. 40,000}}{\text{Rs. 1,60,000}} = 0.25 \end{aligned}$$

$$\begin{aligned} \text{Contribution} &= \text{P/V ratio} \times \text{sales} \\ &= 0.25 \times \text{Rs. 6,00,000} = \text{Rs. 1,50,000} \end{aligned}$$

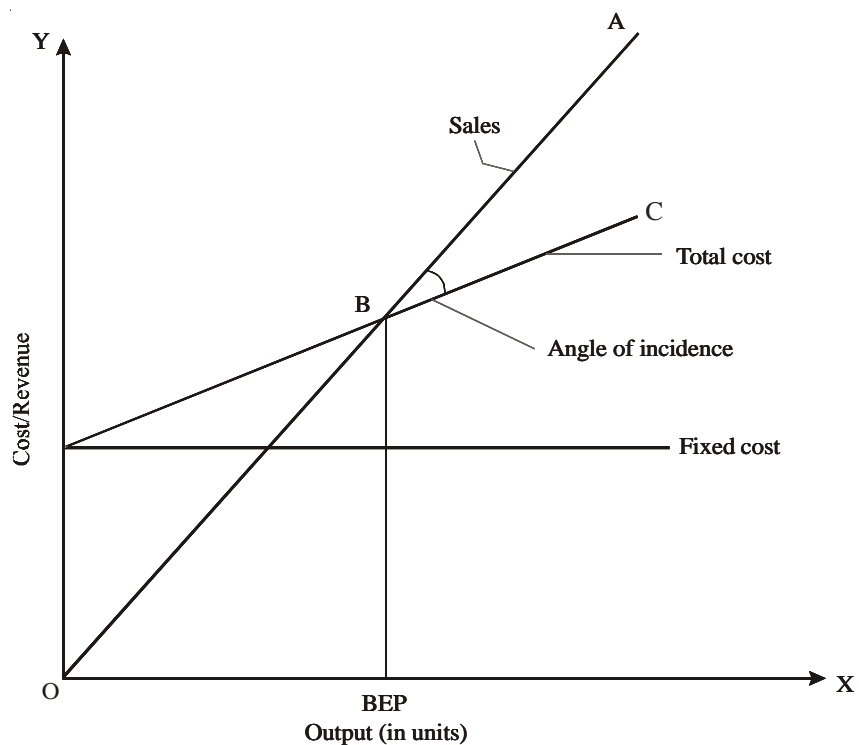
$$\text{Contribution} = \text{Fixed Costs} + \text{Profit}$$

$$\begin{aligned} \text{Fixed Cost} &= \text{Contribution} - \text{Profit} \\ &= \text{Rs. 1,50,000} - \text{Rs. 40,000} \\ &= \text{Rs. 1,10,000} \end{aligned}$$

$$\text{BEP (in value)} = \frac{\text{FC}}{\text{P/V Ratio}} = \frac{1,10,000}{0.25} = \text{Rs. 4,40,000}$$

16.9 ANGLE OF INCIDENCE

The angle formed at the intersection of the total sales revenue line and the total cost line is called the angle of incidence. It depicts the difference between the slope of the total sales revenue line and total cost line. Graphically it is as follows :



Angle ABC is the angle of incidence. It reflects the responsiveness or sensitivity of profit to variation in the volume sold. The higher the angle of incidence, the greater the responsiveness of profits to variation in the sales volume and *vice versa*. In subsection 16.4 of this unit, we observed that small change in sales brings wide fluctuations in profits.

Activity 2

During boom period high angle of incidence is better and in recession period low angle of incidence is better? Comment.

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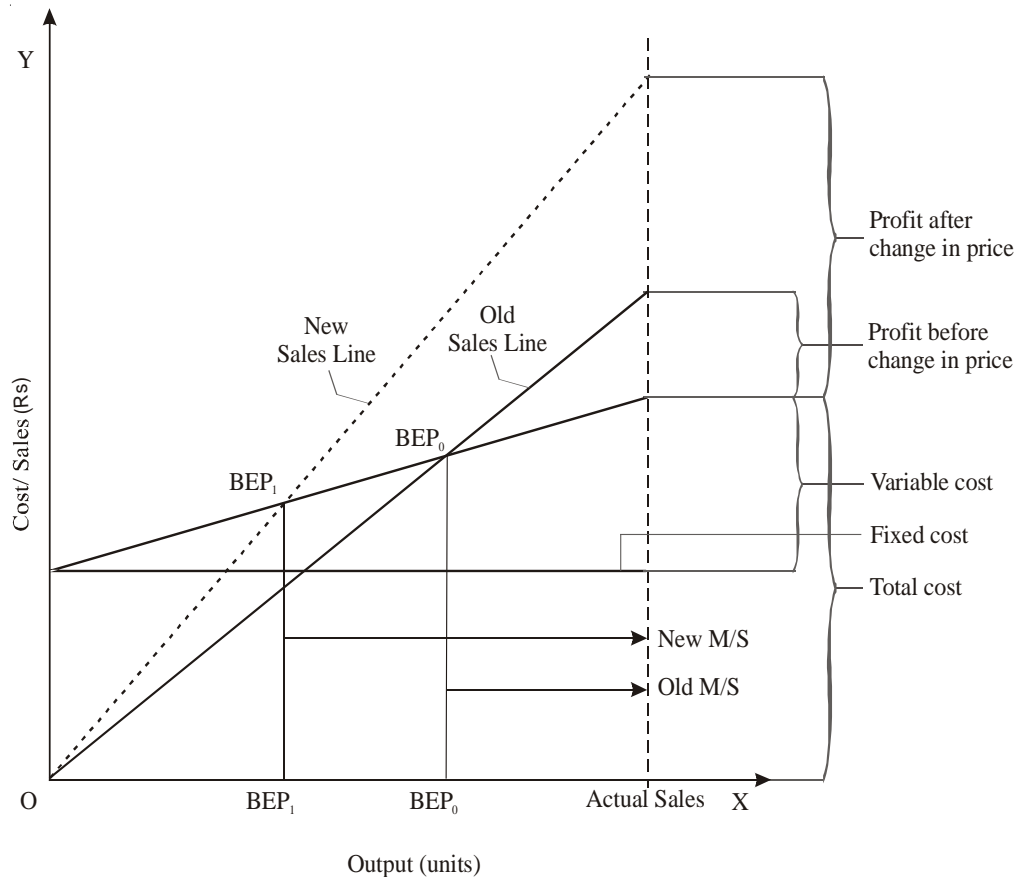
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16.10 BREAK EVEN CHARTS

The effect of change in sales volume, price and costs on profit can be depicted graphically as follows :

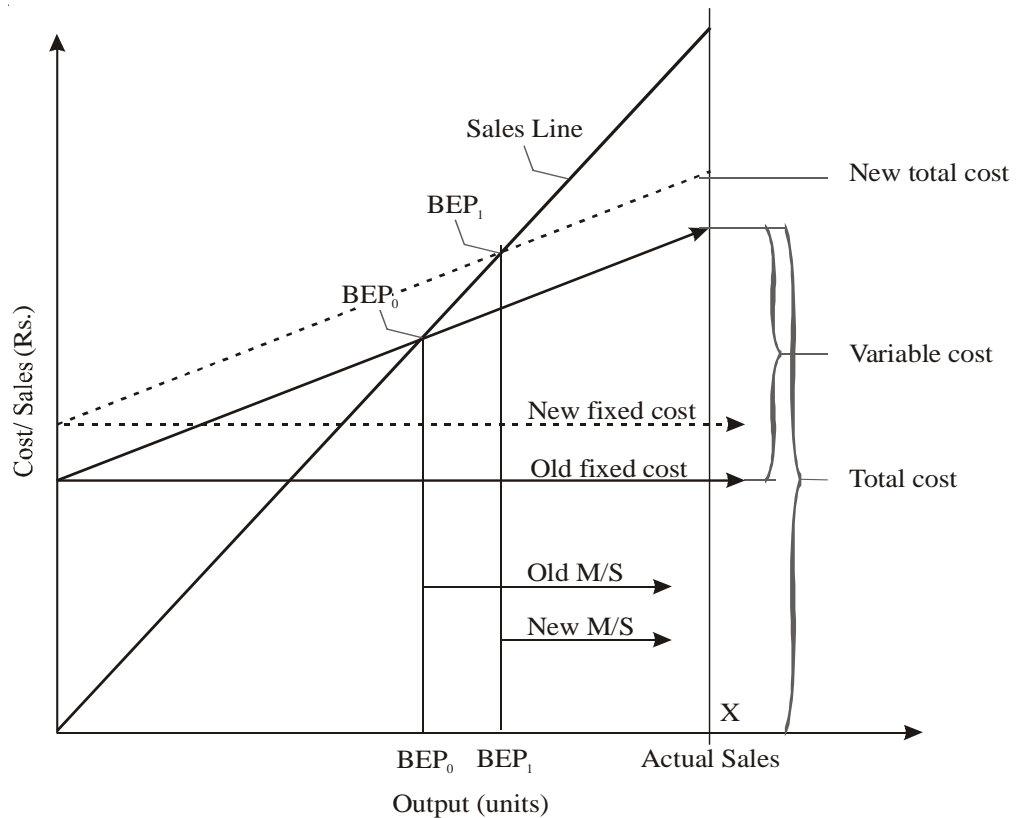
16.10.1 Effect of Price Change on Profit

When price is increased, the slope of sales revenue line become more steep and break even point lowers from BEP_0 to BEP_1 , the margin of safety increases from BEP_0X to BEP_1X angle of incidence also increases. The reverse happens in case of decrease in price.



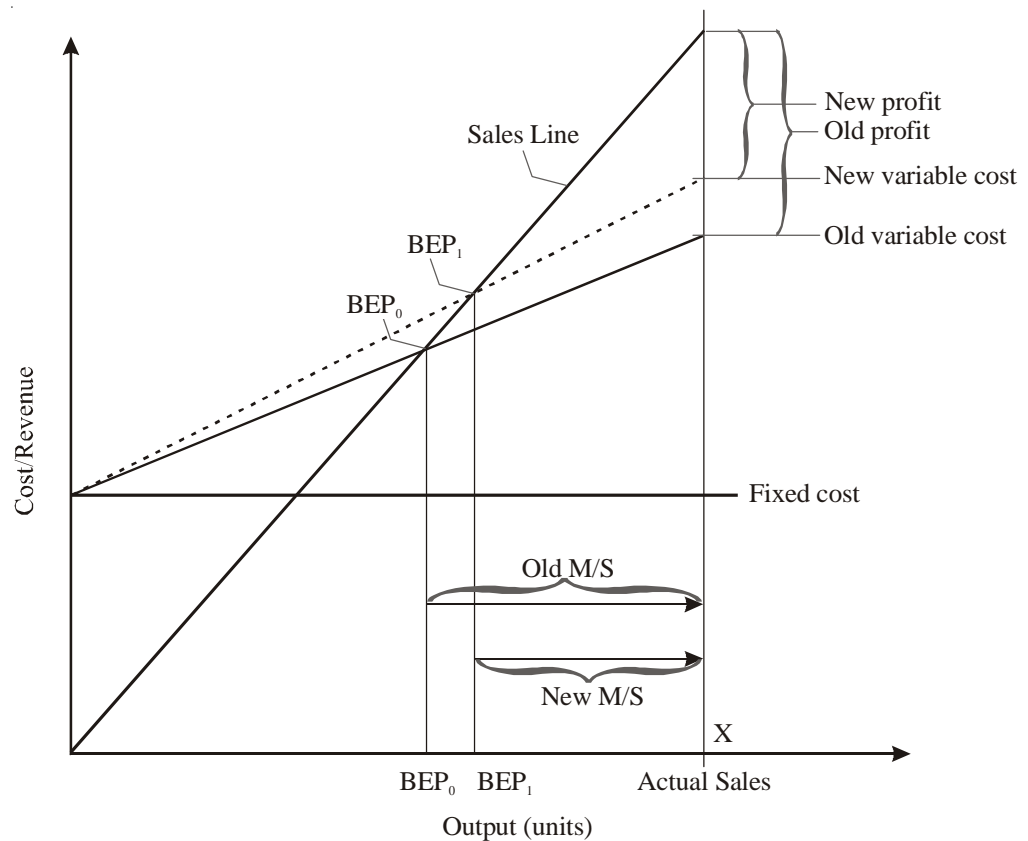
16.10.2 Effect of Change in Fixed Cost on Profit

Increase in fixed cost leads to increase in break even point, lowers the margin of safety and no impact on angle of incidence (Parallel lines)



16.10.3 Effect of Change in Variable Cost

Increase in variable costs leads to higher break even point, lowers the margin of safety and reduces the angle of incidence.



Activity 3

Try to find out the relationships between change in price, fixed cost, variable costs and volume on profit, margin of safety and profit volume ratio through the following equations:

$$\text{Break Even Point (in units)} = \frac{\text{Fixed Cost}}{\text{Sale Price} - \text{Variable Cost Per Unit}}$$

$$\text{Break Even Point (in value)} = \frac{\text{Fixed Costs}}{\text{P/V Ratio}}$$

$$\text{Margin of Safety} = \text{Actual Sales} - \text{Sales at BEP}$$

$$\text{P/V Ratio} = \frac{\text{Sales} - \text{Variable Costs}}{\text{Sales}} = \frac{\text{Contribution}}{\text{Sales}}$$

16.11 PROFIT VOLUME GRAPH

Profit-Volume Graph is the graphical representation of the relationship between profit and volume. It shows profit or loss at different levels of output. It is also called the P/V graph. This type of graph may be preferred to know the profit or loss directly at different levels of activity. Following steps are involved in the construction of profit-volume graph:

- 1) Fixed Costs and profits are depicted on the y-axis or vertical axis.
- 2) Sales are shown on the x-axis or horizontal axis.
- 3) Area above the sales line (x-axis) is a “profit area” and below it is the “loss area”. At zero output, the loss equals to fixed cost. Profit at a particular sales level is depicted on y-axis above the sales line.
- 4) After plotting profits and fixed costs, these two points are joined by a diagonal line which is called profit line or contribution line or fixed cost recovery line or profit-volume line. The break even point occurs at a point where contribution line intersects the horizontal line.

Let us see the following illustration how a P/V graph is prepared.

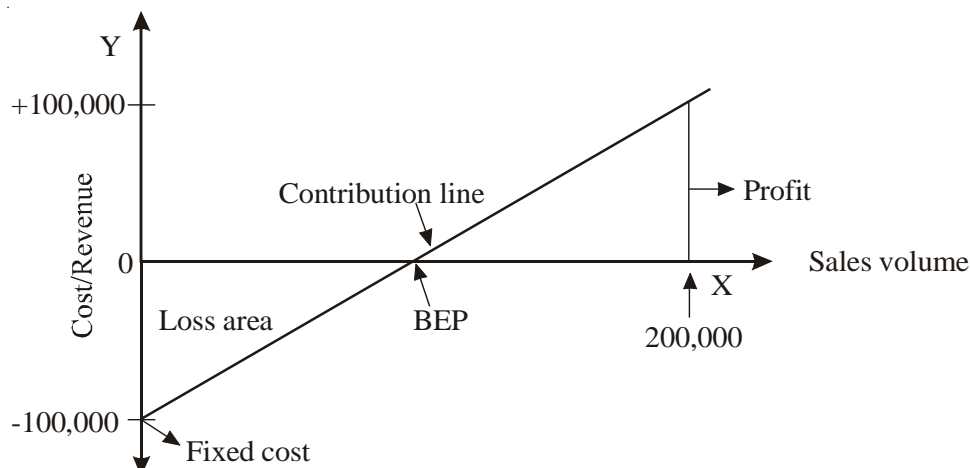
Illustration 13

Prepare a P/V graph with the help of the following data :

Output	=	2,00,000 units
Sales	=	Rs.6,00,000
FC	=	Rs. 1,00,000
VC	=	Rs.4,00,000
Profit	=	Rs.1,00,000

Solution

Profit Volume Graph



Cost Volume Profit Analysis

Better P/V ratio is an index of sound financial health. P/V ratio can be improved by taking following steps:

- Increase in Sale Price
- Decrease in variable costs
- Change in sales mix, i.e. producing more of an item where P/V ratio is high along with demand or dropping or decrease the production of a products whose P/V ratio is very low as per situation.

Illustration 14

ABC Ltd., a multi product company, furnishes the following data:

Particulars	Period I	Period II
Sales (Rs)	45,000	50,000
Total Cost (Rs)	40,000	43,000

Assuming that there is no change in price and variable costs. Fixed expenses are incurred equally in the two periods. Calculate the following :

- i) Profit volume ratio
- ii) Fixed expenses
- iii) Break even point
- iv) Percentage M/S to sales in Period II
- v) Sales required to earn profit of Rs. 10,000
- vi) Profit when sales is Rs. 80,000.

Solution

	Sales (Rs.)	Total Cost (Rs.)	Profit (Rs.)
Period II	50,000	43,000	7,000
Period I	45,000	40,000	5000
Change	5000	3000	2000

i) $P/V \text{ Ratio} = \frac{\text{Change in Profit}}{\text{Change in Sales}} = \frac{\text{Rs. 2000}}{\text{Rs. 5000}} = 0.40$

ii) Fixed expenses

	Contribution	=	Sales × P/V ratio
Period I	Contribution	=	Rs.50,000 × 0.40 = Rs. 20,000
	Contribution	=	Fixed Cost + Profit
	Rs. 20,000	=	F C + Rs. 7000
	F C	=	Rs. 13,000
Period II	Contribution	=	Rs.45,000 × 0.40 = Rs.18,000
	F C	=	Contribution – Profit
		=	Rs.18,000 – Rs.5000 = Rs. 13000

iii) Break even point

	BEP (in value)	=	$\frac{\text{Fixed Costs}}{\text{P/V Ratio}}$
		=	$\frac{\text{Rs.13,000}}{0.40} = \text{Rs. 32,500}$

$$\begin{aligned}
 \text{iv) Margin of Safety (M/S)} &= \text{Actual Sales} - \text{BEP (in value)} \\
 &= \text{Rs. } 50,000 - \text{Rs. } 32,500 \\
 &= \text{Rs. } 17,500 \\
 \text{\% of M/S to sales} &= \frac{\text{Rs. } 17,500}{\text{Rs. } 50,000} \times 100 \\
 &= 35\%
 \end{aligned}$$

$$\begin{aligned}
 \text{v) Sales required to earn a desired profit of Rs. } 10,000 & \\
 &= \frac{\text{FC} + \text{DP}}{\text{P/V Ratio}} \\
 &= \frac{\text{Rs. } 13,000 + \text{Rs. } 10,000}{0.40} \\
 &= \text{Rs. } 57,500
 \end{aligned}$$

$$\begin{aligned}
 \text{vi) Profit when sales is Rs. } 80,000 & \\
 \text{Contribution} &= \text{Sales} \times \text{P/V ratio} \\
 &= \text{Rs. } 80,000 \times 0.40 \\
 &= \text{Rs. } 32,000 \\
 \therefore \text{Profit} &= \text{Contribution} - \text{FC} \\
 &= \text{Rs. } 32,000 - \text{Rs. } 13,000 \\
 &= \text{Rs. } 19,000
 \end{aligned}$$

Activity 4 : Think on the following relationships:

- 1) An increase in selling price increases the amount of contribution resulting in higher P/V ratio or contribution ratio and *vice versa*.
- 2) An increase in fixed cost increases the break-even point but does not affect the P/V ratio.
- 3) An increase in variable cost per unit reduces the contribution per unit, increases the break-even point and lowers the P/V ratio and *vice versa*.
- 4) Increase in P/V ratio lowers the break even point and *vice versa*.

16.12 ASSUMPTION IN BREAK EVEN ANALYSIS

Break even analysis is based on certain assumption, which are:

- 1) All costs can be segregated in two parts *i.e.*, fixed and variable.
- 2) Fixed costs remains constant at various levels of activity.
- 3) Variable costs changes directly with production. It means variable cost per unit remains constant.
- 4) Selling price per unit remains constant at all various levels of activity.
- 5) Technological methods and efficiency of men and machines will not be changed.
- 6) Production and sales are perfectly synchronized *i.e.*, no inventory exists in the beginning or at the end of the period.

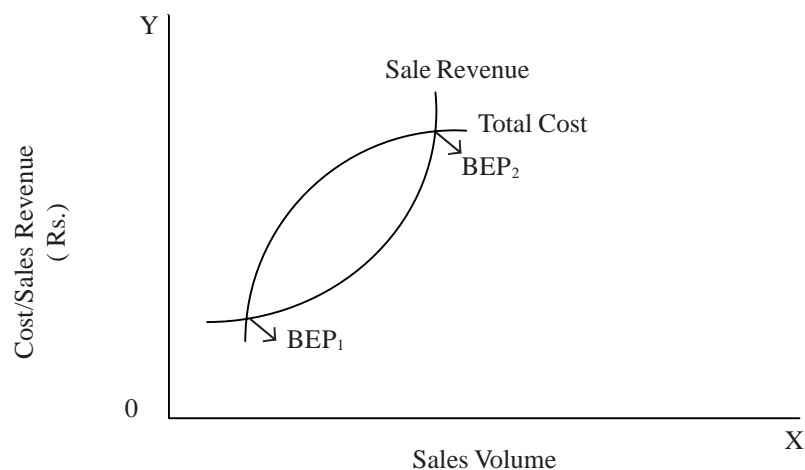
Cost Volume Profit Analysis

- 7) Either there is only one product or if several products are being produced and sold then sales mix remains constant.
- 8) Break even analysis assumes linear relationship in total costs and total revenues.
- 9) Break even analysis ignores the capital employed in the business.

The above assumptions are also the limitations of this analysis *e.g.* selling price per unit and variable cost per unit remains constant at any level of activity. The production and sales can be increased upto the maximum plant capacity so long as contribution is positive. This assumption is valid if it is not necessary to reduce the selling price per unit to increase the sales.

The variable cost per unit do not have a linear relationship with level of production because of laws of return. In economic theory, initially total cost will increase at a decreasing rate, then at a constant rate and finally at an increasing rate.

Further production and sales are not perfectly synchronized as there will be some opening and closing inventory. Technological methods and efficiency of men and machines keeps changing. To increase the sales, price concessions are offered to the customers. The break even chart, therefore becomes curve-linear having the following shape.



In curve-linear model, the optimum production level is where the total revenue exceeds the total cost by the largest amount. There are two break-even points, one at the lower capacity level and other at the higher capacity level. No firm would like to operate at a lower level than BEP_1 as it is a loss zone and beyond BEP_2 point which is again a loss zone. The economist's model is valid over a range of activity and it allows production, inputs costs, selling price to vary. The accountant model is valid only for a short relevant range of activity where only quantity varies, price and cost structure is constant.

Check Your Progress

- A. 1) In cost-volume-profit analysis, profit is determined by
 - a) Sales Revenue x P/V ratio - Fixed Cost
 - b) Sales units x contribution per unit - fixed costs
 - c) Total contribution - Fixed cost
 - d) All the above

- 2) Variable costs per unit
 - a) Goes on increasing with production
 - b) Goes on decreasing with production
 - c) Remains constant with change in production
 - d) None of these
- 3) Variable cost are those which
 - a) Are directly apportioned to cost unit or cost centre
 - b) Varies directly with production
 - c) Depends upon the demand
 - d) Depends upon the sale
- 4) In accounting, marginal cost per unit goes on, _____ with increase in production
 - a) Increases
 - b) Decreases
 - c) Remain constant
 - d) None of these
- 5) Which is not a fixed cost
 - a) Property tax
 - b) Power
 - c) Insurance premium
 - d) Rent
- 6) Fixed cost per unit _____with increase in production
 - a) Increases
 - b) Decreases
 - c) Remains constant
 - d) Can't say
- 7) Semi variable cost are segregated into fixed and variable costs with the help of
 - a) Scatter diagram
 - b) Method of least square
 - c) High and low points method
 - d) All the above
- 8) Telephone charges is a
 - a) Fixed cost
 - b) Variable cost
 - c) Semi-variable cost
 - d) Marginal cost

**Cost Volume Profit
Analysis**

- 9) The break even points in units is equal to
- a) Fixed cost/PV ratio
 - b) Fixed cost x sales/total contribution
 - c) Fixed cost/contribution per unit
 - d) Fixed cost/total contribution
- 10) At the break-even point, which equation will be true.
- a) Variable cost - fixed cost = contribution
 - b) Sales = variable cost + fixed cost
 - c) Sales - fixed cost = contribution
 - d) Sales – contribution = variable cost
- 11) When fixed costs increases, the break even point
- a) Increases
 - b) Decreases
 - c) No effect
 - d) Can't say
- 12) When variable costs decreases, then break even point
- a) Increases
 - b) Decreases
 - c) No effect
 - d) Can't say
- 13) When selling price decreases, then break even point
- a) Increases
 - b) Decreases
 - c) No effect
 - d) Can't say
- 14) When sales increases then break even point
- a) Increases
 - b) Decreases
 - c) Remains constant
 - d) None of these
- 15) Contribution is
- a) Fixed cost + profit
 - b) Sales - variable cost
 - c) Fixed cost – loss
 - d) All the above

- 16) P/V ratio is
- Profit/volume
 - Contribution/sales
 - Profit/contribution
 - Profit/sales
- 17) Profit - volume ratio is improved by reducing
- Variable cost
 - Fixed cost
 - Both of them
 - None of them
- 18) The price reduction policy, _____ the P/V ratio and _____ the break even point
- Reduces, reduces
 - Reduces, increases
 - Increases, reduces
 - Increases, increases
- 19) Shut down point occurs when
- Net profit is zero
 - Sale revenue - variable cost + fixed costs
 - Losses are greater than fixed cost
 - None of the above
- 20) The break even point and shut down point are
- Synonymous
 - Anonymous
 - Different
 - Can't say
- 21) The sales of a firm is Rs. 3,00,000, fixed cost is Rs. 90,000, and variable costs are Rs. 2,00,000, the break even point will occur at
- 2,70,000 units
 - Rs. 2,70,000
 - Rs. 3,25,000
 - 3,25,000 units
- 22) The financial accounts of a firm reveals the position at two time periods is as follows:

Period	Sales Rs.	Profit Rs.
I	2,30,000	50,000
II	3,00,000	80,000

**Cost Volume Profit
Analysis**

- The profit volume ratio for the firm will be
- a) $3/7$
 - b) $5/8$
 - c) $3/8$
 - d) $13/53$
- 23) The fixed cost of a firm is Rs. 90,000, variable cost per unit is Rs. 2 and sale price is Rs. 3 per unit. The break even point will occur at
- a) 30,000 units
 - b) 50,000 units
 - c) 90,000 units
 - d) Rs. 90,000
- 24) The sales volume in value required to earn the target profit, the formula is
- a) Target profit/contribution per unit
 - b) $(\text{Fixed cost} + \text{Target profit}) / \text{P/V ratio}$
 - c) $\text{Fixed cost} + \text{Target profit} / \text{contribution on per unit}$
 - d) $(\text{Fixed cost} + \text{Target profit}) / \text{PV ratio}$
- 25) The contribution per unit is Rs. 2 and fixed costs are Rs. 15,000 for earning a profit of Rs. 50,000, the company must have sales of
- a) Rs. 1,30,000
 - b) Rs. 1,00,000
 - c) 32,500 units
 - d) Rs. 32,500
- 26) Margin of safety is expressed as
- a) Profit / P/V ratio
 - b) $(\text{Actual sales} - \text{sales at BEP}) / \text{Actual sales}$
 - c) $\text{Actual sales} - \text{Sales at BEP}$
 - d) All of the above
- 27) The margin of safety point lies
- a) To the left of break even point
 - b) To the right of break even point
 - c) On break even point
 - d) Can't say

- 28) The sale at a BEP for a firm is Rs. 4,80,000 and the actual sales made by the firm Rs. 8,00,000, the margin of safety will be
- Rs. 12,80,000
 - Rs. 3,20,000
 - Rs. 4,80,000/8,00,000
 - Rs. 800,000
- 29) The profit of a company is Rs. 30,000 by selling 10,000 units at a price of Rs. 10 per unit. The variable cost to sale ratio is 60 per cent. Find margin of safety level.
- Rs. 75,000
 - Rs. 30,000
 - Rs. 1,00,000
 - Rs. 12,000
- 30) In the above question, determine the break even point
- Rs. 20,000
 - Rs. 25,000
 - Rs. 30,000
 - Rs. 40,000

B) State whether the following statement are True or False.

- Contribution is the difference between the total sales and fixed cost []
- At break even point contribution equals to fixed cost []
- Profit volume graph shows profit or loss at different levels of sales []
- Profit volume graph can also be called P/V graph []
- P/V ratio can be improved by decreasing the selling price []
- P/v ratio can be improved by reducing the fixed costs []
- Margin of safety may be improved by increasing selling price and reducing fixed cost []
- At break-even point sales equal to total cost []

16.13 LET US SUM UP

Break even analysis helps in ascertaining the level of production where total costs equals to total revenue. Below this level of production, there are losses and above this point depicts the profit zone. Like marginal costing this analysis is also based on cost classification into fixed and variable costs. Break even analysis helps in measuring the effect of changes in volume, costs, selling price and product mix on profit. In fact, break even analysis is cost-volume profit analysis.

Break even point can be determined both mathematically (equation technique and contribution margin technique) and graphically. It is expressed in terms of units or in

value terms. This technique is very useful in profit planning and decision making. It can be applied to estimate profits at a given sales volume, sales volume required to earn a desired profit, calculating sale volume required to offset price reduction, ascertaining the margin of safety, measuring the effect of changes in profit factors etc. The other tools in this analysis are profit-volume ratio, margin of safety and angle of incidence.

There are inherent limitations in the break even analysis –classification of costs into fixed and variable costs, fixed costs remains fixed, variable cost per unit is constant, selling price per unit is constant etc. In spite of its limitation the break even point is a useful technique in decision making if it used by those who understand its limitations.

16.14 KEY WORDS

Break Even Point is the level of sales (volume or value) where total costs equals to total revenue or no profit no loss point.

Cost-volume-Profit analysis is technique to study the effects of costs and volume variations on profit.

Margin of Safety is the difference between actual sales and sales at break even point. It shows the amount by which sales may decrease before losses occur.

Profit Volume Ratio is a relationship between contribution to sales.

Mixed Costs are those costs which has both fixed and variable elements. These are also known as semi-variable costs.

16.15 ANSWERS TO CHECK YOUR PROGRESS

A

1	d	7	d	13	a	19	c	25	c
2	c	8	c	14	c	20	c	26	d
3	b	9	c	15	d	21	b	27	c
4	c	10	b	16	b	22	a	28	b
5	b	11	a	17	a	23	c	29	a
6	b	12	b	18	b	24	d	30	b

B) i) False ii) True iii) True iv) True v) False vi) False vii) True viii) True

16.16 TERMINAL QUESTIONS

- 1) ‘Cost-volume profit analysis and break even point analysis are same’ Comment?
- 2) What are different methods of computing break even point?
- 3) “The break even chart is an excellent planning device” Comment.
- 4) Explain the significance of Profit-Volume ratio, Margin of Safety and Angle of Incidence?
- 5) What is Contribution ? How does it helps the management in taking managerial decisions?

- 6) Describe three ways to lower down the break even point?
- 7) What are various ways to improve the margin of safety and P/V ratio?
- 8) 'A 10 per cent increase in production and sales leads to more than 10 percent increase in profit' Explain
- 9) ABC Ltd. manufactures and sells four type of products under the brand names of P, Q, R and S. The sale mix in value comprises of 34%, 40%, 16% and 10% of P, Q, R and S respectively. The total budgeted sales (100%) are Rs. 60,000 per month. Operating costs are:

Variables costs ratio is (variable costs on % of sales)

P	60%
Q	65%
R	70%
S	40%

Fixed costs is Rs. 15,000 per month. Calculate the break even point for the products on an overall basis. (Ans BEP Rs. 39062.50)

- 10) Explain from the following data, how the reduction in selling price would affect the break even point and margin of safety.

Selling price per unit	Rs. 20
Variable costs Material	Rs. 6
Labour	Rs. 4
Variable overheads	Rs. 2

Fixed overheads is Rs. 8000. Full capacity of the plant is 5000 units. Reduced selling price is Rs. 16 per unit.

[Ans. BEP increase by 1000 units and M/S decrease by Rs. 32000]

- 11) The sales manager of a company found that with fixed cost Rs. 50,000, sales are increased from Rs. 30,000 to Rs. 4,00,000 and profit increased by Rs. 40,000. Compute the profit when sales is Rs. 5,00,000.

[Ans. Rs. 1,50,000]

- 12) ABC Ltd., has a margin of safety 37.5% with an overall contribution sale ratio of 40%. The fixed cost is Rs. 5 lakhs.

Calculate the following:

- Break even point
- Total Sales
- Total variables costs
- Profit

**[Ans. (i) Rs. 12,50,000 (ii) Rs. 20,00,000 (iii) Rs. 12,00,000
(iv) Rs. 3,00,000]**

- 13) The P/V ratio of a concern is 50% and margin of safety is 40%. Calculate the net profit of the sales is Rs. 1,00,000.

[Ans. Profit Rs. 20,000]

**Cost Volume Profit
Analysis**

- 14) X Ltd has earned a contribution of Rs. 2,00,000 and net profit of Rs. 1,50,000 on sales of Rs. 8,00,000. What is the break even point and margin of safety.

[Ans. Rs. 2,00,000 M/S is Rs. 6,00,000]

- 15) From the following cost information:

	2001	2002
Sales (Rs)	1,50,000	2,00,000
Profit (Rs.)	30,000	50,000

Calculate:

- P/V ratio
- Break even point
- Sales required to earn a profit of Rs. 80,000
- Profit when sales is Rs. 2,50,000

[Ans. (i) 0.40 (ii) Rs. 75,000 (iii) Rs. 2,75,000 (iv) Rs. 70,000]

Note : These questions will help you to understand the unit better. Try to write answers for them. But do not submit your answers to the University. These are for your practice only.

16.17 FURTHER READINGS

Hornngren, C.T., Gary L. Sundem and Frank H. Selto, "*Management Accounting*", Prentice Hall of India, New Delhi, 1994.

Kaplan, R.S., s, Engle Wood Cliffs, NJ., Prentice Hall Inc.