Chapter 9

Break-Even Analysis

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Key words: Profit planning, variable cost, fixed cost, *VCP* analysis, *BEP* point, contribution, margin of safety, *P/V* ratio, and marginal analysis.

Suggested readings:

1. Chandra P. (1970), **Appraisal Implementation**, Tata-McGraw Hill Publishing Company Limited, New Delhi.
2. Gupta P.K. and Mohan M. (1987), **Operations Research and Statistical Analysis**, Sultan Chand and Sons, Delhi.
3. Hampton J.J. (1992), **Financial Decision Making (4th edition)**, Prentice hall of India Private Limited
4. Khan M.Y. and Jain P.K. (2004), **Financial Management (4th edition)**, Tata-McGraw Hill Publishing Company Limited.
5. Swarup K., Gupta P.K. and Mohan M. (2001), **Operations Research**, Sultan Chand and Sons, Delhi.

9.1 Introduction

Decision making is an integral part of most of the processes. One of the most important fields where decision making is used is financial decision making. In this chapter and the following chapters, we will study various aspects of financial decision making. We will learn processes and terms associated with the financial decision making and will see how the aspects which we have learnt till now are useful for the purpose of financial decision making. In this chapter, we will see how the firms can maximize their profits.

An integral part of the financial decision making is profit planning. Profit planning is a function of several components of production, which consists of the method, the cost of production, and the quantity produced the cost of marketing, and the revenue generated from the sale of the product. The Volume- cost - profit (*VCP*) analysis pertains to studying the relationships between the components of the profit planning. One of the techniques of *VCP* analysis is Break- even analysis. In this chapter we shall study the Break-even technique and the applications of this technique in financial decision-making.

We define some basic terms associated with the break-even analysis

Variable cost (*VC*) - *VC* is that cost of production, which varies directly with each unit of production. In other words *VC* increases proportionately with the volume of the production.

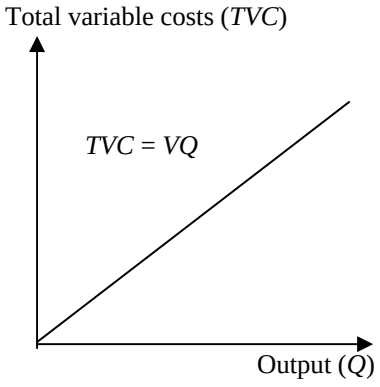

Fig. 9.1(i)

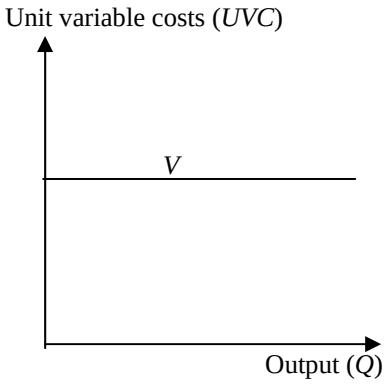

Fig. 9.1(ii)

Fixed cost (*FC*) *FC* is that cost which remains constant irrespective of the changes in the volume of the output. The examples of *FC* include depreciation charges, property tax, insurance, or rent.

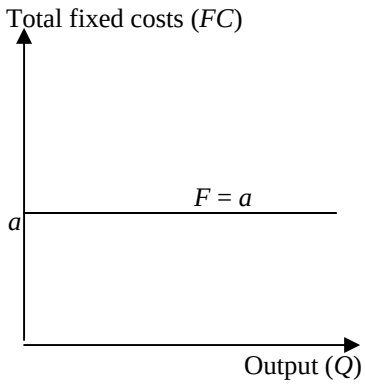

Fig. 9.2(i)

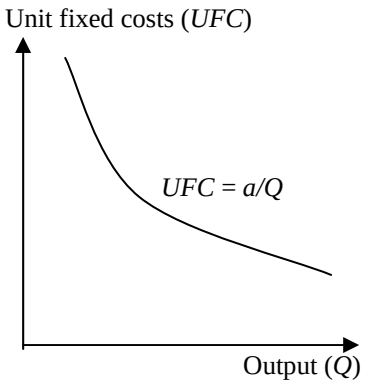

Fig. 9.2(ii)

Fixed costs can either be total fixed costs or the unit fixed cost (fixed for per unit of production). A function of time, the fixed costs arise due to creation of capacity and are invariant with respect to changes in the production.

Semi-variable cost Semi-variable costs are those costs that have both the variable and fixed components. There is a certain base amount that remains fixed irrespective of the level of the activity and another component that varies directly with the level of the activity.

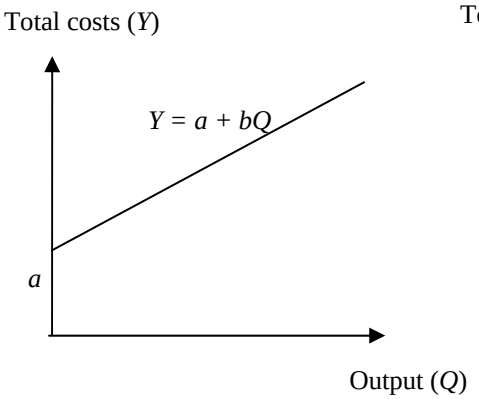

Fig. 9.3(i)

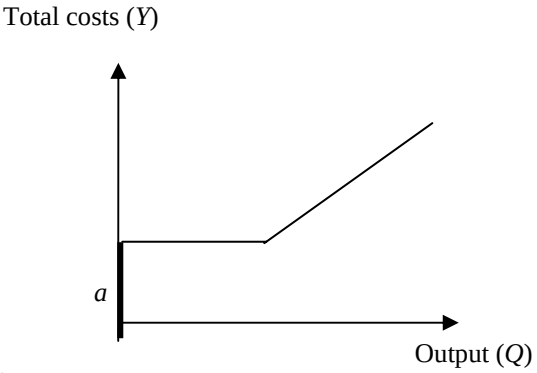

Fig. 9.3(ii)

Here *b* is the unit variable cost.

Examples of the semi-variable costs can be the total amount paid to a sales agent who gets a fixed salary as well as some commission on every deal he cracks.

Another variation of the semi-variable costs is the semi-fixed costs where the costs increases at certain points of production in certain fixed amounts.

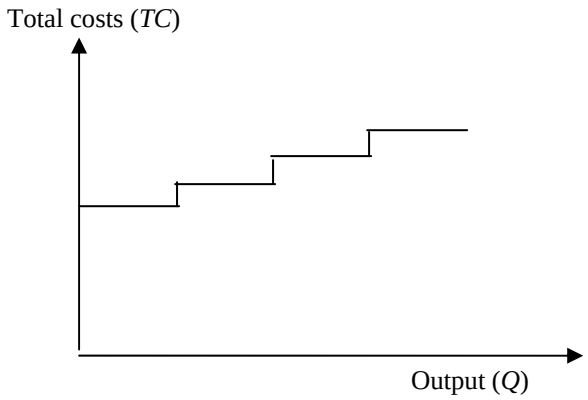

Fig. 9.4

Such costs arise whenever a new item is added to the infrastructure, e.g., installation of a new machine, employment of a new personnel etc.

Break-even point (*BEP*) A *BEP* is that point at which total revenue is equal to the total cost of production (fixed costs and variable costs). At this point, neither a profit is earned nor a loss is incurred.

If all the costs are the variable costs, the *BEP* will be at zero level of production.

Operating profit Operating profit is the difference between the total revenue generated and the total cost (total variable and total fixed costs) before the payment of income tax.

Contribution margin (*CM*) Contribution margin is the difference between selling price and variable cost of one unit of product. This amount directly gives the amount that an additional unit of production contributes to the total profit.

Margin of safety (*MS*) *MS* is the difference between the actual sales revenue (*ASR*) and the break-even sales revenue (*BESR*) (off course, when *ASR* is more than *BESR*.) Larger is *MS*; safer is the producer from making losses even if there is a temporary decrease in profit.

Break-even analysis and the financial decision-making Break-even analysis is a very widely used technique for making effective financial decisions, particularly when we can obtain explicit relationships between the three components of the profit planning. The financial decision-making may be in reference to one or more of the following question

(i) Initial production does not result in profits since it is utilized in making for the expenses incurred in order to start production. Then how much production should be there before it results in (a certain amount of) operating profit?

(ii) For a new product, how much sales volume should be there in order to meet the (fixed) cost of production before it starts making any profit?

(iii) Every production plant has a finite capacity of production. Then for a particular level of production, how much is the operating profit or loss?

(iv) As a result of competition it may become necessary to reduce the prices of the products and consequently the operating profit would be reduced. Then by what extent should the production be increased so as to maintain the earlier levels of operating profit?

(v) Profit is a function of costs. How is profit affected by increase in the fixed costs or decrease in the variable costs?

These and many more such questions can be answered with the help of break- even analysis.

9.2 Techniques of break-even analysis

Break-even analysis can be done by either of the following techniques:

(i) Graphic methods; and

(ii) Algebraic methods.

We shall discuss both the techniques in brief.

(i) **Graphic method**

Under certain assumptions, a break-even chart which is a graphic representation of the relationship between the three components of the profit planning, is a strong tool for answering several questions related with the problem pf profit planning

Assumptions of a *VC*P chart

(i) The costs can be divided into the fixed costs and the variable costs.

(ii) Within the range of the chart, the fixed costs will remain fixed (There is no new addition in the infrastructure of the production).

(iii) Within the range of the chart, the unit variable cost will remain fixed irrespective of the amount of production.

(iv) Within the range of the chart, the unit-selling price will remain fixed irrespective of the amount of sale.

(v) If the production process involves production of more than one product (multi-product production) the product-mix will remain constant within the range of the chart.

(vi) The production and the sales volume are the same, i.e., there is no wastage in marketing the product.

Under these assumptions, now we demonstrate the construction of a *VC*P chart.

Consider the following data, which pertains to a production process:

Table 9.1

Selling price (per unit)			Rs.10
Fixed costs			Rs.60, 000
Variable costs (per unit)			Rs.5
Relevant range of production	Lower limit	6,000	
	Upper limit	20,000	
Break-up of variable costs (per unit)	Direct material	Rs.2	

	Direct labor	Rs.1.50	
	Direct expenses	Re.1	
	Selling expenses	Rs.0.50	
Actual sales (18,000 units)			Rs.1, 80,000
Plant capacity (20,000 units)			Rs.2, 00,000
Tax rate			50%

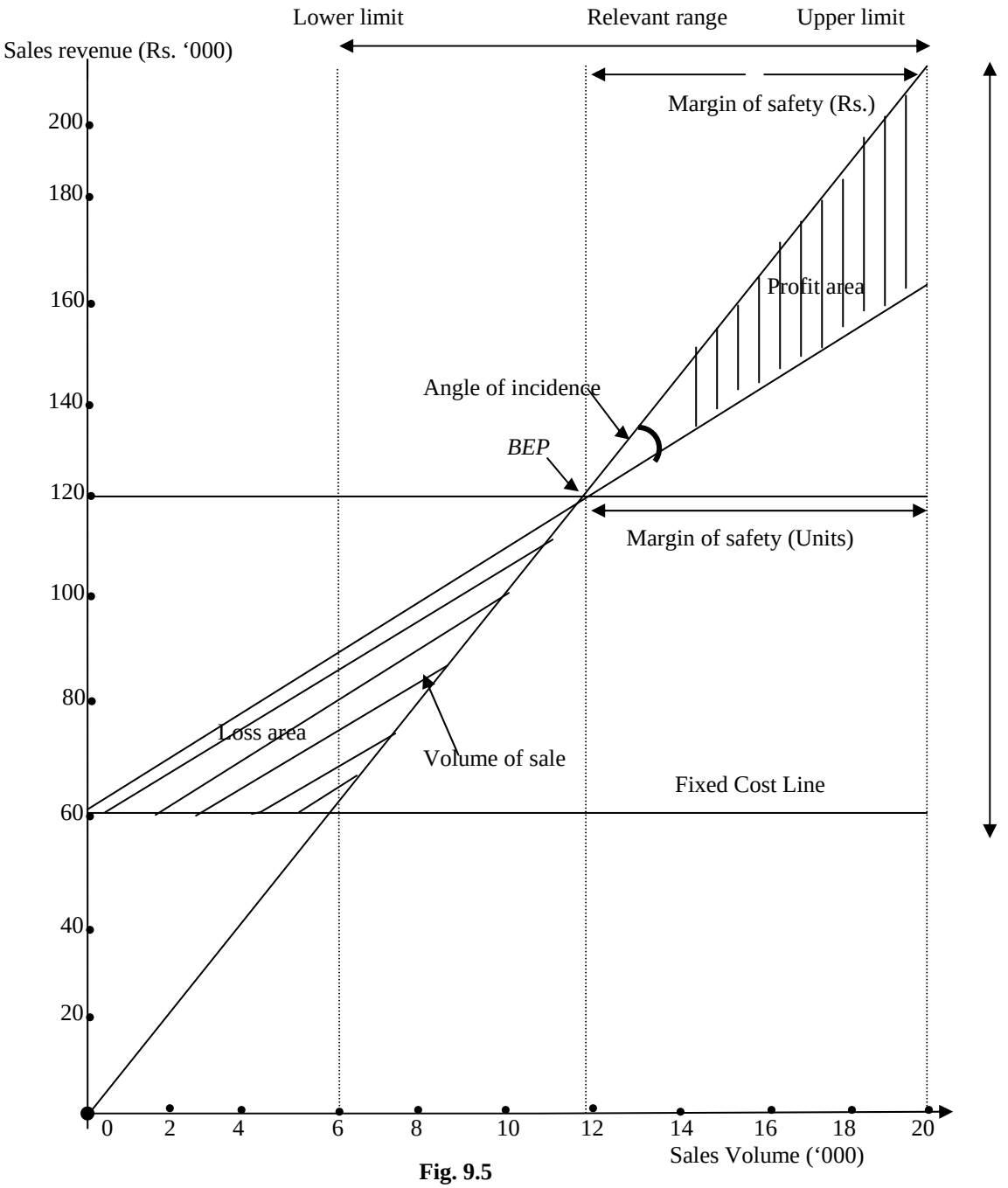

Fig. 9.5

In this case, we represent total sales volume in rupees on the X-axis and the total revenue generated on the Y-axis. Total cost line is starting from the point where fixed cost line is meeting the Y-axis. Fixed cost line is independent of the volume of production Total sale line starts from the origin and goes till the point of maximum production. Then the break –even point (*BEP*) lies at the intersection of the total cost line and the total sale line. This is the point at which the production cost becomes equal to the sales revenue. The area above this point is the profit area and the area below this point is the loss area. The angle between the total cost line and the total sale line, which is subtended at the point of the intersection of the two lines, is called the **angle of incidence** and it provides a measure of the degree safety of the profit. Higher is the angle of incidence; the larger will be the profit after all costs have been recovered. Lower angle shows that the profit is increasing at a low rate after *BEP* thus signifying the fact that the variable costs form a large part of the cost of production.

It is possible to read the details of the individual variable cost segments from a *VC*P graph. Calculating the proportions of different variable costs to the total variable cost, we have the following table

Table 9.2

Cost type	Amount	Proportion	Total cost
Total variable cost	Rs. 5	1.00	1,00000
Direct material	Rs.2	0.40	40,000
Direct labour	Rs.1.50	0.30	30,000
Direct expenses	Re.1	0.20	20,000
Selling expenses	Rs.0.50	0.10	10,000

The corresponding points can be read from the graph

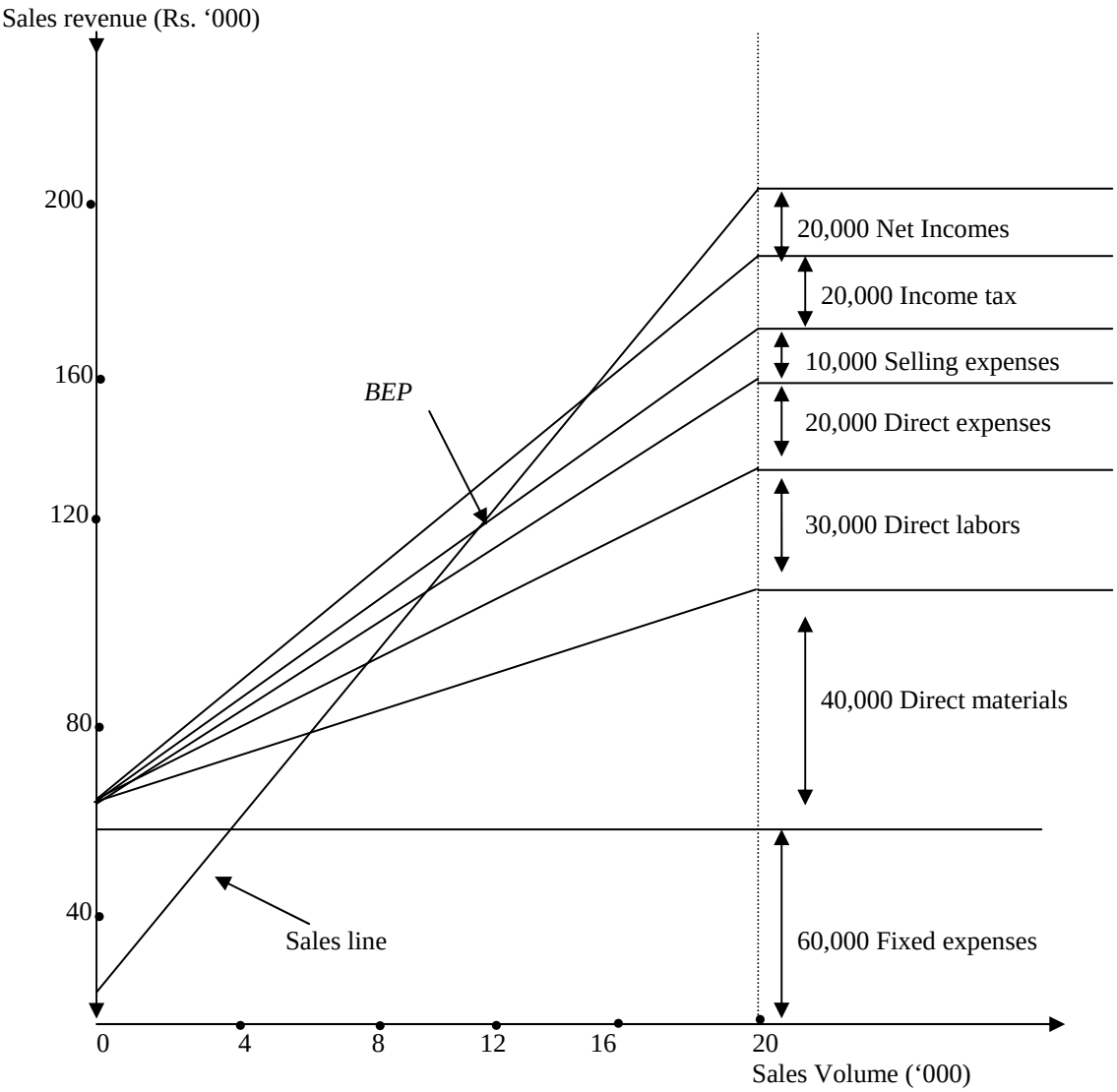

Fig. 9.6

(ii) **Algebraic methods** Algebraic methods of solving *CVP* problems consists of two techniques:

(b) **Contribution margin (*CM*) approach**

$$CM = \text{Sale price per unit - Variable cost per unit}$$

Then

$$BEP(\text{units}) = \frac{\text{Fixed cost}}{CM}$$

$$BEP(\text{sales revenue}) = BEP(\text{units}) \times SP \text{ per unit}$$

$$= \frac{\text{Fixed cost}}{\text{profit-volume } (P/V) \text{ ratio}}$$

$$\text{where } (P/V) \text{ ratio} = \frac{CM \text{ per unit}}{SP \text{ per unit}}$$

and

$$\text{Variable cost to volume } (V/V) \text{ ratio} = \frac{\text{Variable cost}}{\text{sales revenue}}$$

$$P/V + V/V = 1$$

Also

$$M/S = ASR - BESR$$

where *M/S* is the margin of safety, *ASR* is the actual sales revenue and *BESR* is the break-even sales revenue. Then profit can be calculated from any of the following expressions:

$$\text{Profit} = M/S(\text{amount}) \times \text{P/V ratio}$$

$$= M/S(\text{units}) \times CM \text{ per unit}$$

Margin of safety (*M/S*) ratio

$$M/S \text{ ratio} = \frac{M/S}{ASR} = \frac{ASR - BESR}{ASR}$$

M/S ratio is the proportion by which the actual sales may fall before they become less than break-even sales revenue. A high ratio is better from the firm's point of view since it provides a cushion to firm's profitability, particularly in conditions of recession or depression.

(b) **Equation approach** This technique is based on the income equation.

$$\text{Net profit } (NP) = \text{Sales revenue } (SR) - \text{Total cost } (TC)$$

where $TC = FC + VC$

$$\Rightarrow SR = FC + VC + NP$$

If *S* is the number of units required for *BESR*, then

$$SR = SP \times S = FC + VC \times S + NI$$

where

SP = Selling price per unit

NI = Net income (= 0 at BEP)

$$\Rightarrow SP \times S = FC + VC \times S$$

$$\Rightarrow (SP - VC) \times S = FC$$

$$\Rightarrow S = \frac{FC}{(SP - VC)}$$

Thus the equation technique is same as the contribution approach.

Example 1: For XYZ publishers, who publish educational as well as fiction books, the following data relates to their publishing cost and sales revenue for a year

Table 9.3

Particulars	First half of the year (Rs. '00,000)	Second half of the year (Rs. '00,000)
Sales	45	50
Total cost	40	43

Assuming that there is no change in input costs and the selling prices and that the fixed costs are incurred equally during the two halves, calculate

(i) The *P/V* ratio;

(ii) Fixed costs;

(iii) Break-even sales; and

(iv) Percentage margin of safety.

Sol:

Table 9.4

Particulars	First half of the year (Rs. '00,000)	Second half of the year (Rs. '00,000)	Change during the two halves
Sales	45	50	5
Total cost	40	43	3

Net profit	5	7	2

Since the fixed costs have been distributed equally in the two halves, so the change in the costs (Rs. 3,00,000) is on account of the variable costs.

$$\therefore \quad CM = \text{Sale revenue - Variable costs}$$

$$= \text{Rs. } 5,00,000 - \text{Rs. } 3,00,000$$

$$= \text{Rs. } 2,00,000$$

(i)

$$P/V \text{ ratio} = \frac{CM}{SR} = \frac{2,00,000}{5,00,000} = 40\%$$

$$V/V \text{ ratio} = 1 - P/V \text{ ratio} = 60\% \text{ of the sale revenue}$$

(ii)

$$\text{Variable cost for the first half} = \frac{60}{100} \times 45,00,000$$

$$= \text{Rs. } 27,00,000$$

$$\text{Variable cost for the second half} = \text{Variable cost for the first half} + \text{Rs. } 3,00,000$$

$$= \text{Rs. } 27,00,000 + \text{Rs. } 3,00,000$$

$$= \text{Rs. } 30,00,000$$

Now,

$$FC = \text{Sales revenue} - VC - NP$$

$$= \text{Rs. } 95,00,000 - \text{Rs.}57,00,000 - \text{Rs.}12,00,000$$

$$= \text{Rs. } 26,00,000$$

(iii)

$$BEP \text{ (amount)} = \frac{FC}{P/V \text{ ratio}}$$

$$= \frac{26,00,000}{0.40}$$

$$= \text{Rs. } 65,00,000$$

(iv)

$$M/S \text{ ratio} = \frac{ASR - BESR}{ASR}$$

$$= \frac{95,00,000 - 65,00,000}{95,00,000}$$

$$= \frac{30}{95}$$

$$= 31.58\%$$

9.3 Applications of break-even analysis in decision making

(i) Suppose that the management wants to have a net income after taxes (@ 40%) to be Rs. 20,00,000, then the required sales volume to generate this much income can be calculated as follows

$$\text{Required sale} = \frac{FC + \text{desired operating profit}}{P/V \text{ ratio}}$$

$$= \frac{FC + \dfrac{\text{desired income after taxes}}{1 - \text{tax rate}}}{P/V \text{ ratio}}$$

$$= \frac{26,00,000 + \dfrac{20,00,000}{0.60}}{0.40}$$

$$= \text{Rs. } 1,48,33,334$$

In order to generate a profit of Rs, 20,00,000, the company must realize a sale equal to Rs. 1,48,33,334.

(ii) Suppose that the company forecasts an increase in 10% in sales next year. Then, the projected profit can be calculated as follows:

$$\text{Projected profit} = (\text{projected sales revenue} - BESR) \times P/V \text{ ratio}$$

$$= (1,04,50,000 - 65,00,000) \times 0.40$$

$$= 15,80,000$$

(iii) Due to increasing competition in the market, suppose that the company wants to reduce the unit-selling price from Rs. 50 to Rs. 45, still maintaining its presents operating profit. Then it must increase its sales volume which can be calculated as follows:

$$\text{Required sales volume} = \frac{\text{Operating profit} + FC}{\text{revised } P/V \text{ ratio}}$$

Revised *P/V* ratio is calculated as follows

Unit SP = Rs. 50

Total sale = Rs. 95,00,000

Units sold = 190000

Total VC = Rs. 57,00,000

$$\text{Unit } VC = \frac{57,00,000}{190000} = \text{Rs. } 30$$

Total new sale = 190000×40 = Rs. 76,00,000

$$\therefore \text{ revised } P/V \text{ ratio} = \frac{CM \text{ per unit}}{SP \text{ per unit}} = \frac{40\text{-}30}{30} = \frac{1}{3}$$

$$\therefore \text{ Required sales volume} = \frac{12,00,000 + 26,00,000}{\frac{1}{3}}$$

$$= \text{Rs. } 1,14,00,000$$

$$\text{Sales (units)} = \frac{1,14,00,000}{40} = 2,85,000$$

9.4 The *VCP* analysis and the normal probability distribution

As we have seen, the *VCP* analysis can be used for forecasting the consequences of certain decisions or events regarding costs, revenues, and profits.

The two variables affecting profit are costs and revenues. Although both the variables work within certain range, still practically the management does not have much control over the revenue variable. An efficient management can cost variable under control, at least up to some extent.

In fact the variable revenue is a random variable, and can be characterized by a probability distribution.

Consider the following data:

SP = Rs. 75

VC per unit = Rs. 45

FC per year = Rs, 1,50,00,000

Then,

$$BEP \text{ (units)} = \frac{FC}{SP - VC}$$

$$= \frac{1,50,00,000}{75 - 45}$$

$$= 5,00,000$$

Thus 5,00,000 units of the product must be sold per year in order to break – even.

Now, suppose that sales distribution S (the number of units sold), can be described by a normal distribution with mean μ = 6,00,000 and s.d. σ = 3,00,000. Then to estimate the expected profit for the next financial year, we may proceed as follows:

Since the total contribution is a linear function of the random variable S (30 S) so contribution is also a normal variable with mean = 30 μ and s.d. = 30σ, i.e.

$$\text{contribution} \sim N(1,80,00,000 \quad 90,00,000)$$

Then,

$$\text{Expected profit} = \text{expected contribution} - FC$$

$$= 1,80,00,000 - 1,50,00,000$$

$$= 30,00,000$$

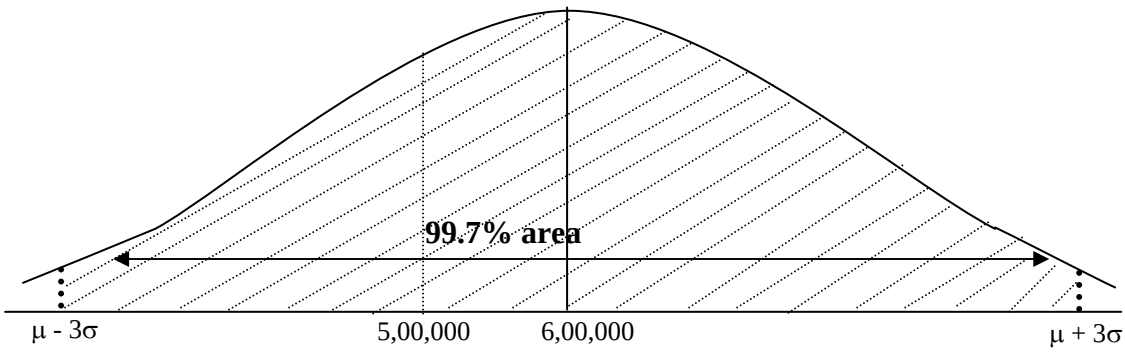

Fig. 9.7

Now, we can use the sale distribution(s) to answer the queries of the management

(i) What is the probability of break-even sale?

$$P(S \geq 5,00,000) = P\left(\frac{S - 6,00,000}{3,00,000} \geq \frac{5,00,000 - 6,00,000}{3,00,000}\right)$$

$$= P(Z \geq -0.3334)$$

$$= 0.5 + P(0 \leq Z \leq 0.3334)$$

$$= 0.6293$$

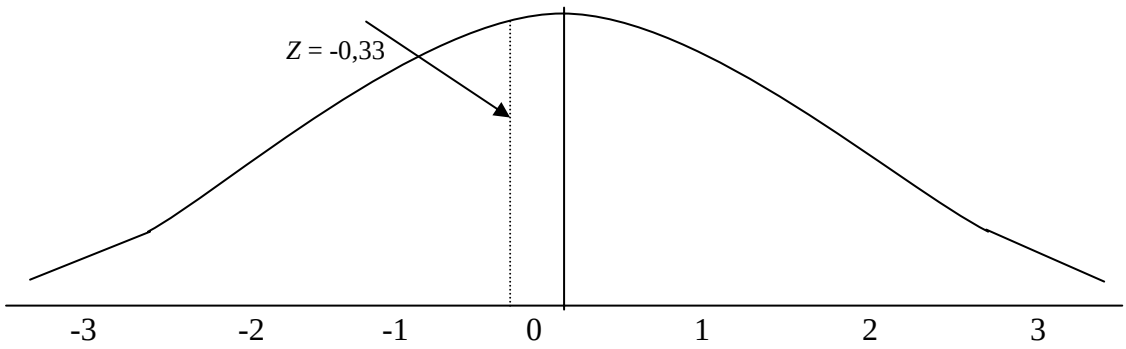

Fig. 9.8

(ii) With what probability can a profit of Rs. 50,00,000 be earned?

$$P(\text{profit} \geq 50,00,000) = P(\text{contribution} \geq 1,50,00,000 + 50,00,000)$$

$$= P(\text{contribution} \geq 2,00,00,000)$$

$$= P\left(\frac{\text{contribution} - 1,80,00,000}{90,00,000} \geq \frac{2,00,00,000 - 1,80,00,000}{90,00,000}\right)$$

$$= P(Z \geq 0.11)$$

$$= 0.5 - P(0 \leq Z \leq 0.11)$$

$$= 0.4562$$

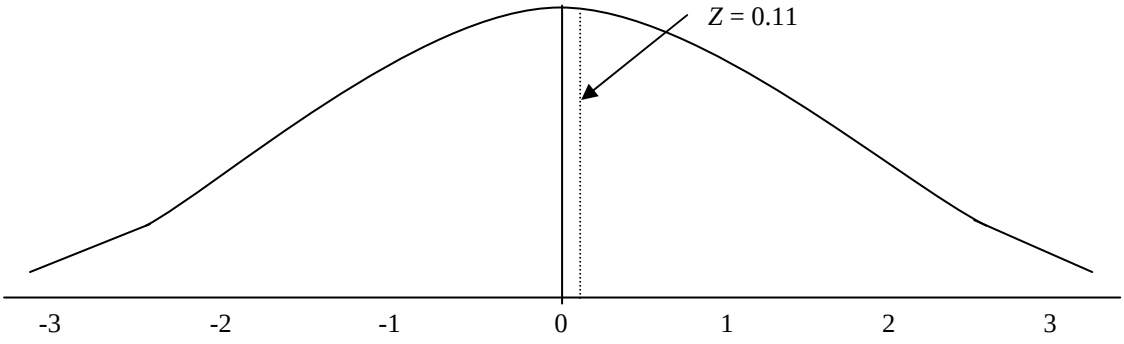

Fig. 9.9

(iii) In order to increase the efficiency of the production, the management is interested in knowing the probability that in case of losses; the loss will not exceed Rs. 20,00,000.

$$P(\text{loss} \leq 20,00,000) = P(\text{contribution} \leq FC - \text{loss})$$

$$= P(\text{contribution} \leq 1,50,00,000 - 20,00,000)$$

$$= P(\text{contribution} \leq 1,30,00,000)$$

$$= P\left(\frac{\text{contribution} - 1,80,00,000}{90,00,000} \leq \frac{1,30,00,000 - 1,80,00,000}{90,00,000}\right)$$

$$= P(Z \leq -0.56)$$

$$= P(Z \geq 0.56)$$

$$= P(0 \leq Z \leq 0.44)$$

$$= 0.17$$

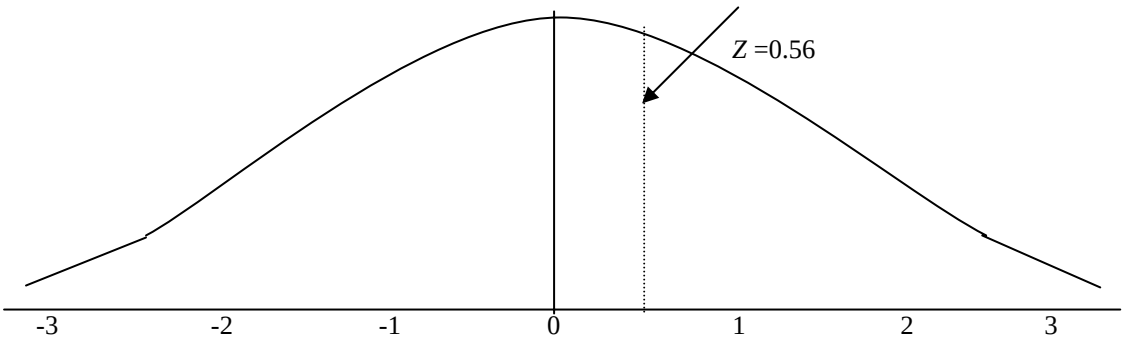

Fig. 9.10

(iv) What is the probability that the sale will be within the interval (4,50,000, 7,50,000)?

$$P(4,50,000 \leq S \leq 7,50,000)$$

$$= P\left(\frac{4,50,000 - 6,00,000}{3,00.000} \leq Z \leq \frac{7,50,000 - 6,00,000}{3,00.000}\right)$$

$$= P(-0.5 \leq Z \leq 0.5)$$

$$= 2\,P(Z \leq 0.5)$$

$$= 0.383$$

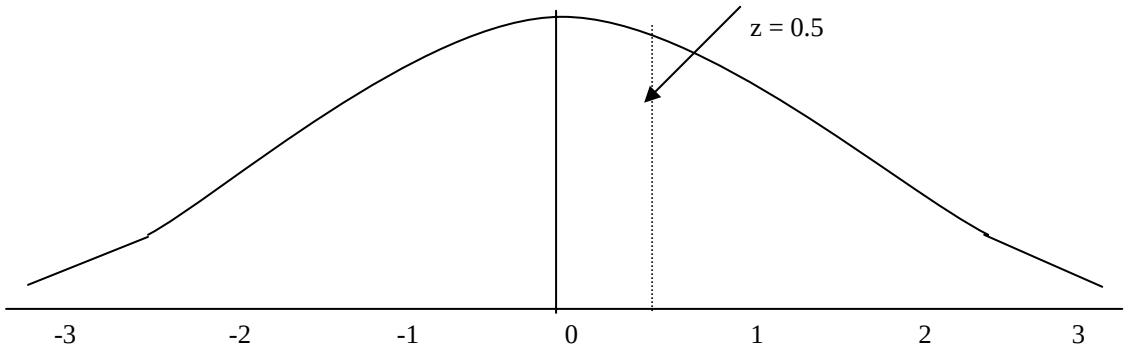

Fig. 9.11

Thus the management has gathered the following conclusions:

(i) There are 63% chances that sale will at least be equal to break-even sale

(ii) There are 46% chances that the profit will be at least Rs. 50,00,000.

(iii) Chances that the losses are up to Rs. 20,00,000 can be incurred are 17%.

(iv) The probability that the sale can be in range (4,50,000 7,50,000) is 0.383.

With these observations, the management may find the taking up of the product as an interesting option.

The normal probability distribution can be used in determining the quantities computed in the earlier examples also, if we can estimate the parameters of the distribution.

9.5 Marginal analysis

Marginal costing This is another technique of taking decisions on the basis of costs involved in a production process. The marginal costs can be defined as the amount of any given volume of output by which the aggregate costs are changed if the volume of output changes by one unit.

Thus the marginal costs are the costs associated with the production of **additional** units. So for this purpose, in short run, only variable costs are taken into consideration. Hence marginal costing is also known as variable costing. Variable costs include direct material, direct labor, variable direct expenses, other variable overheads, and the variable portion of the semi-variable costs. However, in long run fixed costs are also included in the marginal costs.

To illustrate the concept of marginal costs, consider the following example

Example 2: A firm manufactures three products X, Y, and Z. The costs associated with the production process are given below:

Table 9.5

Costs (Rs.)	Products		
	X	Y	Z
Direct material per unit	30	40	50
Direct labour per unit	10	15	20
Selling price per unit	90	100	100
Output (units)	1000	1000	100

The total overheads are Rs. 1,00,000, out of which Rs. 40,000 is fixed and the rest are variable. Find the total profit of the firm.

Sol:

Table 9.6: Statement of cost and profit

Costs (Rs.)	X		Y		Z	
	Per unit (Rs.)	Total (Rs.)	Per unit (Rs.)	Total (Rs.)	Per unit (Rs.)	Total (Rs.)

Direct material	30	30,000	40	40,000	50	50,000
Direct labour	10	10,000	15	15,000	20	20,000
Variable overheads (100000-40000)/3	20	20,000	20	20,000	20	20,000
Total marginal cost	60	60,000	75	75,000	90	90,000
Contribution (*SP – VC*)	30	30,000	25	25,000	10	10,000
Selling price (*SP*)	90	90,000	100	1,00,000	100	1,00,000

Then, we have

$$\text{Total profit} = \text{Total contribution - Fixed costs}$$

$$= \text{Rs.}\mathbf{2,90,000} - \text{Rs.}\mathbf{40,000}$$

$$= \text{Rs. } \mathbf{2,90,000}$$

9.6 Marginal analysis and decision-making

(i) Fixation of selling prices In general, the firm does not have very high control over selling prices as the significant factors governing the selling prices are the prevailing market and the economic conditions, yet the firm does have some control over the fixation of selling prices.

In normal circumstances, in fixing the selling prices, total cost is covered along with a sufficiently high margin to cover the fixed costs and the required profit. But there may be situations when the product may have to be sold at a price below the total price. Such situations may arise due to competition, depression, existence of spare capacity, exploring of new markets etc. In such situations, the firm has to decide about the price at which it is willing or afford to sell its products.

(a) Pricing in depression During depression, the demand falls and as a result the prices also fall. In such situations, the product may have to be sold at a price below the total price. If the product was in production, before the beginning of the depression, the fixed costs will be very much there even if the production is discontinued. So if there is a temporary fall in the demand, the

production should be continued, and the product should be sold at a price equal to the marginal price of the product. Consider the following example

Example 3: The following cost statement shows the prevailing market conditions for a firm

Table 9.7

Total sale (2500 units @ Rs. 30 per unit)					Rs.75, 000
Total cost	Direct material			Rs.50, 000	
	Direct wages			Rs. 15,000	
	Overheads	Variable	Rs. 5,000		
		Fixed	Rs. 15,000	Rs. 20,000	Rs. 85,000
Total loss					Rs. 10,000

There are no signs of the improvement of the situation and the losses are growing. Now the management has to take a decision on whether to continue or discontinue production. Suggest the management the optimal course of action.

Sol: If the production shuts down, still there will be losses of the extent Rs. 15,000 on account of the fixed costs. This loss is greater then the loss incurred if the production is continued. So the advisable course of action is to continue the production.

Table 9.8

Cost		Unit price (Rs.)	Total price (Rs.)
Marginal cost		28	70,000
	Direct material	20	50,000
	Direct labour	6	15,000
	Variable expenses	2	5,000
Revenue		30	75,000
Contribution		2	5,000

Loss = Fixed costs - Contribution

= Rs. 15,000 - Rs. 5,000

= Rs. 10,000

As long as the price is above the marginal cost, the contribution would work to recover the fixed costs.

At this point a decision may be taken to decide about the minimum price at which the production may be continued.

The minimum price at which the production may be continued is equal to the one at one the costs of production can be recovered, i.e., the marginal cost. Thus the production should be continued till the prices drop to Rs. 28 per unit, after which the production should be discontinued.

(b) **Accepting additional orders** Sometimes, in addition to the ongoing production, orders are received in bulk from new or foreign markets, at a price lower than the prices prevailing in the local market or even the total cost of the product. Then the management has to decide the minimum price at which to accept such orders. Consider the following example.

Example 4: Given below is the cost statement of a product, which is being sold in the local market:

Table 9.9

Total output					50,000
Selling price per unit					Rs.20
Total cost	Direct material			Rs. 8	
	Direct wages			Rs. 3	
	Production overheads	Variable	Rs.1.50		
		Fixed	Rs. 1.50	Rs. 3	
	Administrative expenses	Selling	Rs. 0.50		
		Distribution	Re. 1.00	Rs. 1.50	Rs. 15.50

The total output corresponds to the demand of the product in the local markets. However, the plant has a production capacity of 70,000 units. Now the management of the firm has been contacted by a

foreign firm, which is interested in buying 20,000 units at a price of Rs. 14.50. Since the quoted price is less than the total cost of the product, the management is in a fix. What should be the decision of the management? Will the same decision be valid for the home market also?

Sol: In this case, additional production will not affect the fixed costs since the plant is already in work, so we calculate the marginal cost of additional units of production.

Table 9.10

Cost of additional production	Unit cost (Rs.)	Total cost (20,000 units) (Rs.)
Direct material	8	1,60,000
Direct labour	3	60,000
Variable factory overheads	1.50	30,000
Variable administrative overheads	1.50	30,000
Marginal cost	14	2,80,000
Sale	14.50	2,90,000
Contribution	.50	10,000

If the management accepts the additional order, it would give an additional contribution of Rs. 10,000, which would enhance the profit of the firm by the same amount as the fixed expenses have already been met from the local market. Hence the management should go for accepting the order.

However, at this rate the product cannot be sold in the local market since this would lead to the overall reduction in the prices, and hence total cost cannot be met.

(c) Profit planning Profit planning pertains to the planning for future production so as to entail a specified profit. Marginal costing can help to determine the volume of production to achieve this goal. Consider the following example.

Example 5: The cost and sale statement of a product is given below

Table 9.11

Selling price per unit	Rs 20.00

Cost per unit	Direct material			Rs.6.00	
	Direct wages			Rs. 3.00	
	Factory overheads	Variable	Rs. 1.00		
		Fixed	Rs. 1.00	Rs. 2.00	
	Sales overheads	Variable	Rs. 1.00		
		Fixed	Rs. 1.00	Rs. 2.00	Rs. 13.00
Total sale (Units)					75,000

During the current year, the production is 60% of the production capacity. It is estimated that

(i) The fixed cost will go up by 10%;

(ii) The labor cost will go up by 20%;

(iii) The rates of direct material will increase by 7%; and

(iv) The selling price cannot be increased.

Under these restrictions, the company has obtained an order for a further 25% of the capacity of the plant. What should be the minimum price so that the firm makes a profit of Rs. 15,50,000?

Sol: Production capacity of the plant is 1,25,000 units. Currently the production is at 75,000 units. The additional production is 37,500 units.

Table 9.12: Marginal cost statement prior to acceptance of the additional order of 25%

Cost of additional production	Unit cost (Rs.)	Total cost (75,000 units) (Rs.)
Direct material	6.42	4,81,500
Direct labour	3.6	2,70,000
Variable factory overheads	1.00	75,000
Variable administrative overheads	1.00	75,000
Marginal cost	12.02	9,01,500
Sale	20.00	15,00,000
Contribution	7.98	5,98,500

Now, we consider the changes in the fixed component of cost

Table 9.13

Fixed cost:	Per unit (Rs.)	Total (Rs.)
Works overhead Sales overhead	1.10 1.10	82500 82500
Total	2.20	165000
Profit		13,35,000
Planned profit		15,50,000
Increase in profit		1,65,000

Now, we find the minimum price at which the additional units can be supplied

Table 9.14

Variable cost @ Rs.12.02	4,50,750
Add: Increase in profit	1,65,000
New variable cost	6,15,750
Minimum sale price per unit	6,15,750 / 37,500 = Rs.16.42

(d) Decision to make or buy Sometimes the decisions are to be taken regarding whether to manufacture a product or buy it from outside. Such decisions are taken when the product in question is an intermediate product and the system has unutilized capacity. In such situations since no fixed cost is to be incurred on additional production, so decision is taken on the basis of comparison between the marginal cost per unit of production and the unit cost of purchasing from outside. For example, if the additional cost of production is as follows.

Table 9.15

Material	Rs. 5.00
Direct labor	Rs. 2.50
Other variable charges variable	Rs. 2.00
Total additional cost per unit	Rs. 9.50

If the product is available outside at less than Rs. 9.50, it should be purchased from outside; if the product is available at more than Rs. 9.50, it should be manufactured and if the product is available at Rs. 9.50, the company is free to buy or manufacture.

(e) The problem of the key or limiting factor Theoretically, the production of a (most profitable) product can be increased to any extent and there is no limitation in this regard, al least till the plant production capacity allows. However, this is not the situation in general. There are other factors that put a restriction on the production. Such factors are called the limiting or the key factor. The examples of such key factors could be the availability of the material, skilled labor, capital, and market capacity etc. since these factors affect the profitability of the firm, the management must know about these factors. If the key factors are known, then the relative profitability of different products can be worked out to find the most profitable combination of such factors.

Example 6: The following data relates to the production of a face cream and a moisturizing lotion, which compete with each other in the market. Since the consumer group for both the products is same, the company is not finding it economical to continue production of both and wants to discontinue the production of one. Which product should be discontinued?

Table 9.16

Costs	Cream	Lotion
Materials:		
3 units @ Rs. 12 per unit	36	
5 units @ Rs. 15 per unit		75
Labor	12	10
Overheads:		
Variable	5	3
Fixed	8	10
Total cost	61	98
Selling price	75	105
Profit	14	7

Sol:

Table 9.17

Marginal costs	Cream	Lotion
Materials: 3 units @ Rs. 12 per unit 5 units @ Rs. 15 per unit	 36	 75
Labor	12	10
Variable Overheads	5	3
Total marginal cost	53	88
Selling price	75	105
Contribution	22	17
Contribution per unit	7.34	3.4

Since the contribution per unit of face cream is more than that of the moisturizing lotion, hence the company should produce face cream.

A similar situation could be when the company has to choose a profitable product mix. Such situations arise when the company is manufacturing different products and want to determine the optimal quantity of each product to be produced so as to maximize the total profit. Consider the following example:

Example 7: A firm has three alternatives plans for the year to come:

(a) To produce and sell 20,000 units of product X and 25,000 units of product Y;

(b) To produce and sell 30,000 units of product X and 15,000 units of product Y; and

(c) To produce and sell 40,000 units of product X and 10,000 units of product Y.

The following table gives the sale and cost estimates of the two products

Table 9.18

Costs (per unit)	X	Y
Material	3	4
Labour	2	1
Variable overheads	1.50	1
Total cost per unit	6.50	6
Selling price per unit	8	7
Fixed cost	12000	12000

Find the best plan for the firm for the year to come.

Sol:

Table 9.19

Costs (per unit)	X	Y
Total cost	6.50	6
Selling price per unit	8	7
Contribution	1.50	1

Plan (a):

Table 9.20

Description	Cost (Rs.)
Total cost:	
X (20,000 units)	1,30,000
Y (25,000 units)	1,50,000
	2,80,000
Sale	
X (20,000 units)	1,60,000
Y (25,000 units)	1,75.000
	3,35,000

Total contribution X (20,000 units) Y (25,000 units)	 30,000 25,000 55,000
Less: Fixed cost	12,000
Net profit	43,000

Plan (b):

Table 9.21

Description	Cost (Rs.)
Total cost: X (30,000 units) Y (15,000 units)	 1,95,000 90,000 2,85,000
Sale X (30,000 units) Y (15,000 units)	 2,40,000 1,05.000 3,45,000
Total contribution X (30,000 units) Y (15,000 units)	 45,000 15,000 60,000
Less: Fixed cost	12,000
Net profit	48,000

Plan (c):

Table 9.22

Description	Cost (Rs.)
Total cost: X (40,000 units) Y (10,000 units)	 2,60,000 60,000 3,20,000

Sale X (40,000 units) Y (10,000 units)	 3,20,000 70.000 3,90,000
Total contribution X (40,000 units) Y (10,000 units)	 60,000 10,000 70,000
Less: Fixed cost	12,000
Net profit	58,000

Since plan (c) is giving the maximum profit, so it should be executed although in this case contribution of the product Y is negative, but it is supported by the huge margin of product X.

(f) Evaluation of alternative methods of production Sometimes alternative methods of production can be used to produce the same product. In such situations, the management has to decide about the method to be adopted. For example, batch production or continuous production. Marginal costing can effectively be used in such situations. Consider the following example:

Example 8: The production In-charge of a company is planning to acquire a new machine in the factory. He has two options before him: (a) To buy a large machine which would cost him Rs. 20,00,000 and can produce 500 units per hour; or (b) to buy two small machines which would cost him Rs. 17,00,000 and would do him a production of 350 units per hour. He has estimated the following costs associated with the two options:

Table 9.23

Description	Per unit	
	Large machine	Small machines
Marginal cost	50	44
Selling price	75	75
Fixed cost	10	15

If the number of machine hours (per machine) available per year is 1500, which alternative should he opt for?

Sol: We calculate the annual contribution expected for each of the two options

Table 9.24

Description	Large machine	Small machines
Selling price per unit	75	75
Less: marginal cost	50	44
Contribution per unit	25	31
Output per hour	500	350
Contribution per hour	12,500	10,850
Machine hours per year	1,500	1,500
Annual contribution	1,87,50,000	1,62,75,000
Less fixed cost	75,00,000 (=10*500*1500)	78,75,000 (=15*350*1500)
Net profit	1,12,50,000	84,00,000

Thus a large machine should be opted.

Problems

1. For the following data, Find *BEP* units and *BEP* (Rs.)

SP = Rs. 5 per unit

Units sold = 2.8 million

VC per unit = Rs. 2.5

FC per year = Rs, 22,50,000

(a) What should be the fixed cost if the break-even point has to be 2.8 million units?

(b) How many units should the firm produce if it has to realize a profit of Rs. 10,00,000?

(c) What should be the *SP* per unit if the firm has to realize the same profit as in (b) if the firm is producing at its full capacity?

2. For the following data, Find *BEP* units and *BEP* (Rs.)

(a)

SP = Rs. 240 per unit

FC per year = Rs, 10,00,000

Marginal contribution = 25%

(b)

FC per year = Rs, 10,00,000

Variable cost = Rs. 12 per unit

Marginal contribution = 30%

3. In problem 2, find the sale for parts (a) and (b) if the firm wants to make a profit of Rs. 50 million and the corporate tax is 35%.

4. Consider the following data

SP per unit = Rs. 50

FC = Rs, 22,00,000

Variable cost = Rs. 30 per unit

Find the profit if the company sells

(a) 1,00,000 units; (ii) 2,00,000 units; and (iii) 5,00,000 units.

5. In the above problem find the optimal course of action if

Table 9.25

SP per unit (Rs.)	Sale (Units)
60	75,000
50	1,00,000
45	1,25,000

6. Consider the following data

Table 9.26

Cost per unit	Direct material			Rs.5.00
	Direct wages			Rs. 3.00
	Factory overheads	Variable	Rs. 1.25	
		Fixed	Rs. 1.00	Rs. 2.25
	Administrative overheads	Variable	Rs. 0.75	
		Fixed	Rs. 0.75	Rs. 1.50

The same product is available in the market at Rs. 10.50. Should the firm produce the product or buy it from outside?

7. Consider the following data

Table 9.27

Selling price per unit					Rs 25.00
Cost per unit	Direct material			Rs.6.00	
	Direct wages			Rs. 1.50	
	Factory overheads	Variable	Rs. 3.00		
		Fixed	Rs. 5.00	Rs. 8.00	

	Sales overheads	Variable	Rs. 0.50		
		Fixed	Rs. 1.00	Rs. 1.50	Rs. 17.00
Total sale (Units) (60% 0f the potential capacity)					1,20,000

For the current year the estimates are

(a) Fixed costs will go up by 15%;

(b) Direct labor will go up by 8%;

(c) Direct material will go up by 5%; and

(d) *SP* is to be reduced by 5%.

Under these circumstances, an additional order of 25% of the capacity is anticipated. What minimum price will ensure

(a) Break-even of costs; and

(b) A profit of Rs. 2,00,000.

8. From the following information, calculate the break-even point turn-over required to earn a profit of Rs. 30,000

Fixed overheads = Rs, 20,000

SP per unit = Rs. 5

Variable cost = Rs. 2 per unit

(a) If the firm is earning a profit of Rs. 30,000, find the margin of safety available to the firm.

(b) At a break-even point of 1,000 units, the variable costs were Rs. 15,000 and the fixed costs were Rs. 10,000. Find the contribution of 1001^{st} unit before tax.

(c) At a selling price of Rs. 3 per unit, the management expects to break even. If the *P/V* ratio is 40%, what are the fixed and the variable costs?

9. A company is considering the production of an item that can be sold for Rs. 20 per unit. The unit variable cost is Rs. 12 and the fixed annual costs are Rs. 3,00,000. It has been estimated

that the annual sales will have a normal distribution with mean 2,50,000 and standard deviation 80,000.

(a) What is the expected profit per year?

(b) Find the probability of incurring a loss.

10. A machine, when new, can be used on average 5,000 hours per year with a standard deviation of 900 hours. To break-even the machine must be operated al least 2,700 hours per year. Below break-even point the machine would give a loss of Rs. 20 per hour. The profit above *BEP* is Rs. 24 per hour.

(a) Find the expected loss of the machine.

(b) What is the probability of earning a profit of rs. 15,000 or more per year?

(c) What is the probability of operating the machine for at least 4,000 hours per year? In this case, find the expected profit.

11. An adventure tour organizer organizes summer camps for which he has to make arrangements several months before. He approximates the number of campers by dividing the total profit earned last year by the variable cost per camper. The variable cost per camper is Rs. 4,000 and the fixed costs are Rs. 10,00,000 per year. He charges Rs. 7,500 per camper. The organizer estimates that the number of participant per year has a normal distribution with mean 5,000 and s.d. 600.

(a) What is the expected profit for the next year?

(b) If the loss per traveler is Rs. 2,000, how many travelers can join the camp and still break-even?

(c) What is the probability that the number of campers lies between 3,500 and 6,500?