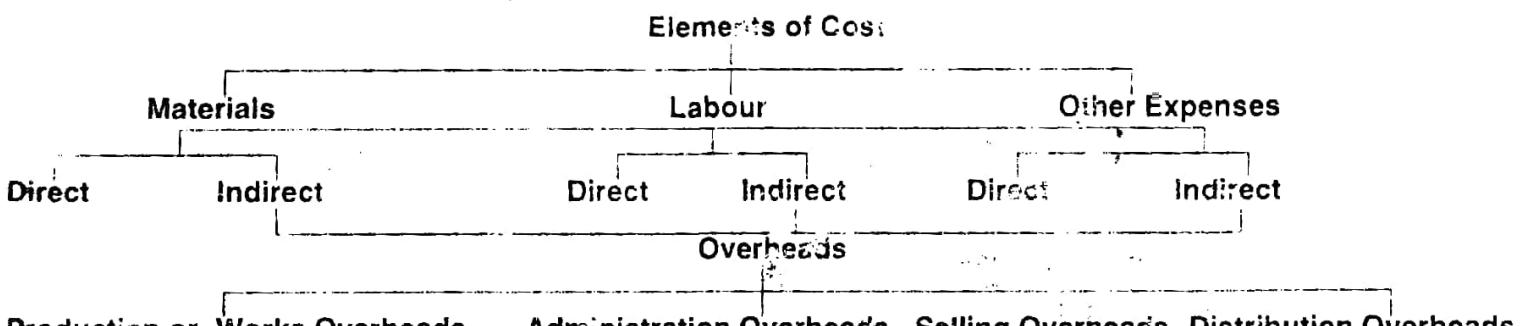


CHAPTER 2

Cost—Analysis, Concepts and Classifications

ELEMENTS OF COST

Mere knowledge of total cost cannot satisfy the needs of management. For proper control and managerial decisions, management is to be provided with necessary data to analyse and classify costs. For this purpose, the total cost is analysed by elements of cost i.e., by the nature of expenses. Strictly speaking, the elements of cost are three i.e., materials, labour and other expenses. These elements of cost are further analysed into different elements as illustrated in the following chart.



By grouping the above elements of cost, the following *divisions of cost* are obtained :

1. Prime Cost = Direct Materials + Direct Labour + Direct Expenses
2. Works or Factory Cost = Prime Cost + Works or Factory Overheads.
3. Cost of Production = Works Cost + Administration Overheads.
4. Total Cost or Cost of Sales = Cost of Production + Selling and Distribution Overheads

The difference between the cost of sales and selling price represents profit or loss.

Now all these terms will be examined in detail one by one.

1. **Direct Materials** are those materials which can be identified in the product and can be

conveniently measured and directly charged to the product. Thus, these materials directly enter the production and form a part of the finished product. For example, timber in furniture making; cloth in dress making and bricks in building a house. The following are normally classified as direct materials :

- (i) **All raw materials** like jute in the manufacture of gunny bags, pig iron in foundry, and fruits in canning industry.
- (ii) Materials **specifically purchased** for a specific job, process or order like glue for book-binding, starch powder for dressing yarn.
- (iii) **Parts or components purchased or produced** like batteries for transistor-radios and tyres for cycles.
- (iv) **Primary packing materials** like cartons, wrappings, cardboard boxes, etc. used to protect finished product from climatic conditions or for easy handling inside the factory.

From the above discussion it becomes clear that indirect materials are those materials which cannot be classified as direct materials. Examples of indirect materials are : consumables, like cotton waste, lubricants, brooms, rags, cleaning materials, materials for repairs and maintenance of fixed assets, high speed diesel used in power generators etc.

Classification of materials into direct and indirect facilitates material control. Direct materials are usually high value items as compared to indirect material and need strict control and critical analysis for reducing their cost. On the other hand, simple control techniques are sufficient in case of indirect materials being low value items.

However, in some cases, though the material is a part of the finished product yet it is not treated as direct material ; for example, sewing thread in dress making and nails in furniture making. This is because they are used in comparatively small quantities and it would be futile elaboration to make an analysis of them for the purpose of direct charge. Such materials are treated as indirect materials. Thus, it can be concluded that the ease and the feasibility with which a material can be traced into the composition of a finished product will determine what is to be treated as direct material.

2. Direct Labour is all labour expended in altering the construction, composition, confirmation or condition of the product. In simple words, it is that labour which can be conveniently identified or attributed wholly to a particular job, product or process or expended in converting raw materials into finished goods. Wages of such labour are known as direct wages. Thus, it includes payment made to the following groups of labour:

- (i) Labour engaged on the actual production of the product or carrying out of an operation or process.
- (ii) Labour engaged in aiding the manufacture by way of supervision, maintenance, tools setting, transportation of material etc.
- (iii) Inspectors, analysts etc. specially required for such production

The wages paid to supervisors, inspectors, etc., though not direct labour, can be treated as direct labour if they are directly engaged on specific product or process and the hours they spend on it can be directly measured without much of an effort. Similarly where the cost is not significant like the wages of trainees or apprentices, their labour though directly spent on a product is not treated as direct labour.

3. Direct (or Chargeable) Expenses. All expenses which can be identified to a particular cost centre and hence directly charged to the centre are known as direct expenses. In other words all expenses (other than direct materials and direct labour) incurred specifically for a particular product, job, department etc. are called direct expenses. These are directly charged to the product. Examples of such expenses are royalty, excise duty, hire charges of a specific plant and equipment, cost of any experimental work carried out specially for a particular job, travelling expenses incurred in connection with a particular contract or job etc.

4. Overheads may be defined as the aggregate of the cost of indirect materials, indirect labour and such other expenses including services as cannot conveniently be charged direct to specific cost units. Thus overheads are all expenses other than direct expenses. In general terms, overheads comprise all expenses incurred for or in connection with the general organisation of the whole or part of the undertaking i.e., the cost of operating supplies and services used by the undertaking and including the maintenance of capital assets. The main groups into which overheads may be

sub-divided are : (i) Manufacturing Overheads ; (ii) Administration Overheads (iii) Selling Overheads ; (iv) Distribution Overheads and (v) Research and Development Overheads.

(a) **Manufacturing or Production or Works Overhead.** It is the indirect expense of operating the manufacturing divisions of a concern and covers all indirect expenditure incurred by the undertaking from the receipt of the order until its completion ready for despatch either to the customer or to the finished goods store. Examples of such expenses are : depreciation and insurance charges on fixed assets like plant and machinery, works, building, and electric equipments and floating assets like stores, finished goods etc.; repairs and maintenance of fixed assets ; electricity charges ; coal and other fuel charges; rent, rates and taxes on works, land and properties, works office printing, stationery, postage, telegrams and telephone charges ; welfare services like canteen and recreation clubs ; medical services like dispensary and hospital and service department expenses. It also includes wages of indirect workers, indirect materials such as lubricants, cotton wastes and other factory supplies, salaries and other costs related to tool room, design and drawing office, production control and progress department.

(b) **Administration Overhead.** It is the indirect expenditure incurred in formulating the policy, directing the organisation, controlling and managing the operations of an undertaking which is not related directly to a research, development, production or selling activity or function. It consists of all expenses incurred in the direction, control and administration (including secretarial, accounting and financial control) of an undertaking. Examples are the expenses in running the general office e.g. office rent, light, heat, salaries and wages of clerks, secretaries and accountants, credit approval, cash collection and treasurer's department, general managers, directors, executives ; legal and accounting machine services ; investigations and experiments and miscellaneous fixed charges.

(c) **Selling Overhead.** It is the cost of seeking to create and stimulate demand and of securing orders and comprises the cost of soliciting and recurring orders for the articles or commodities dealt in and of efforts to find and retain customers. It refers to those indirect costs which are associated with marketing and selling (excluding distribution) activities. Examples are sales office expenses ; salesmen's salaries and commission ; showroom expenses ; advertisement charges ; fancy packing to attract sales ; samples and free gifts ; after sales service expenses; demonstration and technical advice to potential customers; cost of marketing information system and costs of catalogues and price lists.

(d) **Distribution Overhead.** It is the expenditure incurred in the process which begins with making the packed product available for despatch and ends with making the reconditioned return empty package, if any available for reuse. It comprises all expenditure incurred from the time the product is completed in the works until it reaches its destination. Under these would be included warehouse rent ; warehouse staff salaries, insurance etc. ; expenses on delivery van and trucks ; expenses on special packing for bulk transport like bales, crates, chests etc. ; losses in warehouse stocks and finished goods damaged in transit and cost of repairing and reconditioning of empties and wastage of finished goods.

(e) **Research and Development Expenses.** Research cost is the cost of searching for new and improved products, new applications of materials or products and new applications and improved methods. Development cost is the cost of the process which begins with the implementation of the decision to produce a new or improved method and ends with the commencement of formal production of that product or by that method.

Overheads can also be classified as indirect materials, indirect labour and indirect expenses.

(i) **Indirect Materials.** Such materials refer to those materials which do not normally form a part of the finished product. It has been defined as "materials which cannot be allocated but which can be apportioned to or absorbed by cost centres or cost units". These are :

- (a) **Stores used in maintenance of machinery, building** etc. like lubricants, cotton waste, bricks and cements ;
- (b) **Stores used by the service departments** i.e. non-productive departments like power house, boiler house and canteen etc. ; and
- (c) Materials which due to their *cost being small*, are not considered worthwhile to be treated as direct materials.

Examples of indirect materials are stores consumed for repair and maintenance work, sundry stores of small value expended for factory use, small tools for general use, lubricating oil, losses, deficiencies and deterioration of stores etc.

(ii) **Indirect Labour.** The wages of that labour which cannot be allocated but which can be apportioned to or absorbed by cost centres or cost units is known as indirect labour. In other words wages paid to labour which is employed other than on production constitute indirect labour costs. Examples of such labour are : charge-hands and supervisors ; maintenance workers ; departmental coolies ; men employed in service departments, material handling and internal transport ; apprentices, trainees and instructors; works clerical staff and labour employed in time office and security office, holiday pay, leave pay, employer's contribution to funds, miscellaneous allowances to labour.

(iii) **Indirect Expenses** are expenses which cannot be allocated but which can be apportioned to or absorbed by cost centres or cost units as rent, rates, insurance, municipal taxes, general manager's salary, canteen and welfare expenses, power and fuel, cost of training new employees, lighting and heating, telephone expenses. So, under indirect expenses two types of expenses are included : (a) such type of expenditure in respect of which payments are made for services rendered or supplies made. Amount in respect of such expenditure will be found from the voucher registers on the dates on which they are incurred, (b) such items which do not involve any payments and are mere adjustment transactions e.g., depreciation.

EXPENSES EXCLUDED FROM COSTS

The total cost of a product should include only those items of expenses which are a charge against profit. *Items of expenses which are relating to capital assets, capital losses, payments by way of distribution of profits and matters of pure finance should not form a part of the costs.* Examples of such expenses are—income-tax, dividends, abnormal wastage of material, abnormal idle time, interest on capital given or received, expenses of raising capital, discount on shares and debentures, profit or loss from the sale of asset or investments, excessive depreciation, appropriation of profits, writing off goodwill, preliminary expenses and underwriting commission ; cash discount, debentures interest, incomes which are not connected with business i.e., transfer fees, rent, interest, dividend received and capital expenditure.

COST SHEET OR STATEMENT OF COST

Cost sheet is a statement designed to show the output of a particular accounting period alongwith break-up of costs. The data incorporated in cost sheet are collected from various statements of accounts which have been written in cost accounts, either day-to-day or regular records.

There is no fixed form for preparation of a cost sheet but in order to make the cost sheet more useful it is generally presented in columnar form. The columns are for the total cost of the current period, per unit for the current period, total cost and per unit cost for a preceding period and total and per unit cost for the budget period and so on. The information to be incorporated in a cost sheet would depend upon the requirement of management for the purpose of control.

Cost sheet is a memorandum statement. Therefore, it does not form part of double entry cost accounting records. Inspite of this, the relationship between cost sheet and financial accounts which are maintained on double entry system is very important as cost sheet derives its data from financial accounting. In case predetermined rates are not used, the entire data required for preparation of cost sheet is derived from financial accounting. Therefore, periodically it becomes necessary to reconcile the information obtained from cost accounting and financial accounting separately.

The main advantages of a cost sheet are :

- (1) It discloses the total cost and the cost per unit of the units produced during the given period.
- (2) It enables a manufacturer to keep a close watch and control over the cost of production.
- (3) By providing a comparative study of the various elements of current cost with the past results and standard costs, it is possible to find out the causes of variations in costs and to eliminate the adverse factors and conditions which go to increase the total cost.
- (4) It acts as a guide to the manufacturer and helps him in formulating a definite useful production policy.
- (5) It helps in fixing up the selling price more accurately.
- (6) It helps the businessman to minimise the cost of production when there is a cut throat competition.

- (7) It helps the businessman to submit quotations with reasonable degree of accuracy against tenders for the supply of goods.

SPECIMEN OF COST SHEET OR STATEMENT OF COST

Units :

	Total Cost	Cost per unit
	Rs.	Rs.
Direct Materials		
Direct Labour		
Direct Expenses		
	<i>Prime Cost</i>	
Add : Works Overheads		
	<i>Works Cost</i>	
Add : Administration Overheads		
	<i>Cost of Production</i>	
Add : Selling and Distribution Overheads		
	<i>Total Cost or Cost of Sales</i>	

Treatment of Stock

Stock requires special treatment while preparing a cost sheet. Stock may be of raw materials, work-in-progress and finished goods.

Stock of Raw Materials

If opening stock of raw materials, purchases of raw materials and closing stock of raw materials are given, then with the help of the following, raw materials consumed can be calculated as given below :

	Rs.		
Opening Stock of Raw Materials	x	x	x
Add : Purchases of Raw Materials	x	x	x
	<hr/>	<hr/>	<hr/>
	x	x	x
Less : Closing Stock of Raw Materials	x	x	x
Cost of Raw Materials Consumed	<hr/>	<hr/>	<hr/>
	x	x	x

Stock of Work-in-Progress

Work-in-progress means units on which some work has been done but which are not yet complete. Work-in-progress is valued at prime cost or works cost basis, but the latter is preferred. Instructions in this respect should be carefully noted from the language of the question. If it is valued at works or factory cost then opening and closing stock will be adjusted as follows :

	Rs.		
	<i>Prime Cost</i>	x	x
Add : Factory Overheads Incurred		x	x
Add : Work-in-Progress (Beginning)		x	x
	<hr/>	<hr/>	<hr/>
	x	x	x
Less : Work-in-Progress (Closing)		x	x
Factory or Manufacturing or Works Cost		<hr/>	<hr/>
	x	x	x

Stock of Finished Goods

If opening and closing stocks of finished goods are also given, then these must be adjusted before calculating cost of goods sold as under :

	Rs.		
	<i>Cost of Production</i>	x	x
Add : Opening Stock of Finished Goods		x	x
	<hr/>	<hr/>	<hr/>
	x	x	x
Less : Closing Stock of Finished Goods		x	x
Cost of Goods Sold		<hr/>	<hr/>
	x	x	x

10. What are imputed costs and common costs ? (C.S. Inter)
 11. "Opportunity cost is a measure of benefit of opportunity foregone". (CS Inter)
 12. State, with reasons, whether the following statements are correct or incorrect :
 (i) Notional cost and imputed costs mean the same thing.
 (ii) Conversion costs and overheads are interchangeable terms. (CS Inter)

LONG ANSWER TYPE

1. Tabulate the elements of cost showing the usual items of expenditure pertaining to each.
2. Bring out clearly the significance of each of following cost classifications and explain the meaning of the terms used therein :
 (i) Direct and Indirect ; (ii) Variable and Fixed ; (iii) Controllable and Uncontrollable.
3. (a) "The classification of costs as controllable and non-controllable depends upon a point of reference." Explain.
 (b) "Direct costs and controllable costs are not necessarily the same". Comment.
4. Write notes on :
 (i) Conversion cost ; (ii) Sunk cost ; (iii) Opportunity cost ; (iv) Imputed cost ; (v) Cost centre ; (vi) Cost unit ; (vii) Differential cost ; (viii) Out of pocket cost ; (ix) Operating costs.
5. Distinguish between :
 (i) Avoidable and Unavoidable costs ; (ii) Cost centre and cost unit ; (iii) Product costs and Period costs; (iv) Direct costs and Indirect costs ; (v) Capital costs and Revenue costs ; (vi) Opportunity costs and Imputed costs ; (vii) Sunk costs and Incremental costs ; (viii) Differential costs and Residual costs; (ix) Absolute costs and Alternative costs ; (x) Urgent and Postponable costs ; (xi) Prime cost and Conversion cost ; (xii) Out of pocket cost and Opportunity cost ; (xiii) Variable cost and direct cost ; (xiv) Estimated cost and standard cost ; (xv) Variable cost and cost variance ; (xvi) Conversion cost and Added value. (xvii) Explicit and implicit cost ; (xviii) Period costs and discretionary costs ; (xix) Imputed cost and common cost.
6. The term 'cost' must be qualified according to its context. comment (C.S. Inter)
7. What are direct expenses ? Explain them with suitable examples.
8. Do you agree with the view that cost should be presented in different ways for different purposes ? Support your view with suitable Illustrations.
9. (a) Discuss the classification of costs according to time factor of cost determination.
 (b) Describe in brief three major elements of cost.
10. "Cost may be classified in a variety of ways according to their nature and the information needs of management". Explain and discuss this statement giving examples of classifications required for different purposes.
11. 'Notional costs' and 'imputed costs' mean the same thing. Comment. (C.S. Inter)
12. What is a cost centre and how does it differ from a department of a factory ?
13. Explain the nature of product and period costs. How do they affect net income of a business enterprise?
14. Draw a Proforma Cost Sheet. (C.S. Inter)
15. Explain controllable and non-controllable costs with Illustrations. (C.A. Inter)

PRACTICAL PROBLEMS

1. From the following particulars prepare a Cost Sheet showing the total cost per tonne for the period ended 31st March, 2007.

	Rs.	Rs.
Raw materials	33,000	Rent and taxes (office) 500
Productive wages	38,000	Water supply (works) 1,200
Unproductive wages	10,500	Factory insurance 1,100
Factory rent and taxes	7,500	Office insurance 500
Factory lighting	2,200	Legal expenses 400
Factory heating	1,500	Rent of warehouse 300
Motive power	4,400	Depreciation of
Haulage (works)	3,000	—Plant and machinery 2,000

Director's fees (works)	1,000	—Office building	1,000
Director's fees (office)	2,000	—Delivery vans	200
Factory cleaning	500	Bad debts	100
Sundry office expenses	200	Advertising	300
Estimating Expenses (works)	800	Sales department's salaries	1,500
Factory stationery	750	Upkeep of delivery vans	700
Office stationery	900	Bank charges	500
Loose tools written off	600	Commission on sales	1,500

The total output for the period has been 14,775 tonnes.

Ans. [Cost per tonne Rs. 8]

Hint : [Prime Cost Rs. 71,000; Factory Cost Rs. 1,08,050; Cost of Production Rs. 1,13,600; Total Cost Rs. 1,18,200]

2. A manufacturing concern requires a statement showing the result of its production operation for September, 2006. Cost records give the following information:

	1st Sep., 2006	30th Sep., 2006
	Rs.	Rs.
Raw Material	1,00,000	1,23,500
Finished Goods	71,500	42,000
Work-in-Progress	31,000	34,500

Transactions during the month of September, 2006 :

	Rs.
Purchase of Raw Materials	88,000
Direct Wages	70,000
Works Expenses	39,500
Administration Expenses	13,000
Sale of Factory Scrap	2,000
Selling and Distribution Expenses	15,000
Sales	2,84,000

Ans. [Raw Material Consumed Rs. 64,500 ; Prime Cost Rs. 1,34,500 ; Factory Cost Rs. 1,68,500 ; Cost of Production Rs. 1,81,500 . Cost of Goods Sold Rs. 2,11,000 ; Cost of Sales Rs. 2,26,000 ; Profit Rs. 58,000]

3. From the following particulars, prepare a Cost Statement showing the components of Total Cost and Profit for the year ended 31st March, 2007.

	1-4-2006	31-3-2007	
	Rs.	Rs.	Rs.
Stock of finished goods	6,000	15,000	
Stock of raw materials	40,000	50,000	
Work-in-progress	15,000	10,000	
			Sales for the year
Purchase of raw materials	4,75,000		8,60,000
Carriage inward	12,500		500
Wages	1,75,000		1,000
Works Manager's salary	30,000		5,000
Factory employees' salaries	60,000		Transfer to Sinking Fund for replacement of machinery
Factory rent, taxes and insurance	7,250		10,000
Power expenses	9,500		Goodwill written off
Other production expenses	43,000		Payment of sales tax
General expenses	32,500		Selling expenses

Ans. [Prime Cost Rs. 6,52,500 ; Works Cost Rs. 8,07,250 ; Cost of Production Rs. 8,39,750 ; Cost of Goods Sold Rs. 8,39,750 ; Cost of Sales Rs. 8,40,000 ; Profit Rs. 20,000].

4. The cost of sale of product A is made up as follows :

	Rs.	Rs.
Materials used in manufacturing	60,000	Indirect Expenses—Factory
Materials used in primary packing	10,000	Administration Expenses

Materials used in selling the product	1,500	Depreciation on Office	
Materials used in the factory	750	Building and Equipment	750
Materials used in the office	1,250	Depreciation on Factory Building	1,750
Labour required in producing	10,000	Selling Expenses	3,500
Labour required for factory supervision		Freight on materials purchased	5,000
	2,000	Advertising	1,250

Assuming that all the products manufactured are sold what should be the selling price to obtain a profit of 20% on selling price?

Ans. [Selling Price Rs. 1,25,000]

Hints : [Prime Cost Rs. 85,000 ; Works Cost Rs. 90,500 ; Cost of Production Rs. 93,750 ; Cost of Sales Rs. 1,00,000 ; Profit Rs. 25,000].

5. The books of Adarsh Manufacturing Company presents the following data for the month of April, 2007. Direct labour cost Rs. 17,500 being 175% of the works overhead ; cost of goods sold excluding administration expenses Rs. 56,000.

Inventory accounts showed the following opening and closing balances :

	April 1	April 30
	Rs.	Rs.
Raw materials	8,000	10,600
Work-in-progress	10,500	14,500
Finished Goods	17,600	19,000

Other data are :

	Rs.
Selling expenses	3,500
General and administration expenses	2,500
Sales for the month	75,000

You are required to :

- (i) Compute the value of materials purchased
- (ii) Prepare a statement showing the various elements of cost and also the profit.

Ans. [(i) Rs. 36,500 ; (ii) Prime Cost Rs. 51,400 ; Works Cost Rs. 61,400 ; Cost of Goods Manufactured Rs. 57,400 ; Cost of Sales Rs. 62,000 ; Profit Rs. 13,000]

6. Vindhyaachal Industries manufacture a Product X.

On 1st January, 2006, there were 500 units of finished product in stock. Other stocks on 1st January, 2006 were as under :

	Rs.
Work-in-Progress	5,740
Raw Materials	11,620

The information available from cost records for the year ended 31st December, 2006 was as follows:

	Rs.	Rs.	
Indirect Labour	12,160	Work-in-Progress on 31-12-2006	7,820
Direct Labour	32,640	Sales—15,000 units	3,60,000
Freight on Raw Material Purchased	5,570	Indirect Materials	21,390
Stock of Raw Materials on 31-12-2006	9,640	Total Manufacturing	
Other Factory Expenses	31,730	Cost Incurred	1,94,080

There are 1,500 units of product in finished goods stock on 31st December, 2006. You are required to : (i) Prepare a statement of cost for 2006 giving all details of cost and their break up, and (ii) Determine the unit cost at which finished goods stock is to be properly valued at the beginning and at the end of 2006 (assuming the same cost used for both).

Ans. [Prime cost Rs. 1,28,800 ; cost of goods manufactured Rs. 1,92,000 : Rs. 12 per unit cost of stock, Profit Rs. 1,80,000].

Hint : Raw Materials purchased Rs. 88,610].

7. The following figures are extracted from the Trial Balance of Gogetter Co. on 30th September, 2006 :

	Rs.	Rs.	
	<i>Debit Balances</i>	<i>Debit Balances</i>	
Opening Inventories .		Repairs and Upkeep—Factory	14,000
Finished Stock	80,000	Heat, Light and Power	65,000
Raw Materials	1,40,000	Rates and Taxes	6,300

Work-in-Progress	2,00,000	Miscellaneous Factory Expenses	18,700
Office Appliances	17,400	Sales Commission	33,600
Plant & Machinery	4,60,500	Sales Travelling	11,000
Building	2,00,000	Sales Promotion	22,500
Sales Return and Rebates	14,000	Distribution Dept.—Salaries and Expenses	18,000
Materials Purchased	3,20,000	Office Salaries and Expenses	8,600
Freight incurred on Materials	16,000	Interest on Borrowed Funds	2,000
Direct Labour	1,60,000	<i>Credit Balances</i>	
Indirect Labour	18,000	Sales	7,68,000
Factory Supervision	10,000	Purchase Returns	4,800

Further details are available as follows :

- (i) Closing Inventories : Rs.

Finished Goods	1,15,000
Raw Materials	1,80,000
Work-in-Progress	1,92,000
- (ii) Accrued expenses on : Rs.

Direct Labour	8,000
Indirect Labour	1,200
Interest on Borrowed Funds	2,000
- (iii) Depreciation to be provided on :

Office Appliances	5%
Plant and Machinery	10%
Buildings	4%
- (iv) Distribution of the following costs :

Heat, Light and Power to Factory, Office and Distribution in the ratio of 8 : 1 : 1.
 Rates and Taxes two-thirds to Factory and one-third to Office.
 Depreciation on Buildings to Factory, Office and Selling in the ratio of 8 : 1 : 1.

With the help of the above information, you are required to prepare :

- (i) a statement of cost showing various elements of cost and
- (ii) a statement of profit.

Ans. [Prime Cost Rs. 4,59,200; Works Cost Rs. 6,37,750, Cost of Production Rs. 6,56,620; Cost of Goods Sold Rs. 6,21,620; Cost of Sales Rs. 7,14,020; Net Operating Profit Rs. 39,980; Net Profit Rs. 35,980]

- (vii) It helps to make the managers more responsible for the costs and services provided to their centres/departments due to correct allocation and apportionment of fixed factory overheads.
- (viii) It helps to calculate the gross profit and net profit separately in income statement.

Limitations of Absorption Costing

The following are the main limitations of absorption costing :

1. Difficulty in comparison and control of cost. Absorption costing is dependent on level of output ; so different unit costs are obtained for different levels of output. An increase in the volume of output normally results in reduced unit cost and a reduction in output results in an increased cost per unit due to the existence of fixed expenses. This makes comparison and control of cost difficult.

2. Not helpful in managerial decisions. Absorption costing is not very helpful in taking managerial decisions such as selection of suitable product mix, whether to buy or manufacture, whether to accept the export order or not, choice of alternatives, the minimum price to be fixed during the depression, number of units to be sold to earn a desired profit etc.

3. Cost vitiated because of fixed cost included in inventory valuation. Under absorption costing, a portion of fixed cost is carried forward to the next period because closing stock is valued at cost of production which is inclusive of fixed cost.

4. Fixed cost inclusion in cost not justified. Many accountants argue that fixed manufacturing, administration and selling and distribution overheads are period costs and do not produce future benefits and, therefore, should not be included in the cost of product.

5. Apportionment of fixed overheads on arbitrary methods. The validity of product costs under this technique depends on correct apportionment of overhead costs. But in practice many overhead costs are apportioned by using arbitrary methods which ultimately make the product costs inaccurate and unreliable.

6. Not helpful for preparation of flexible budget. Under absorption costing no distinction is made between the fixed and variable costs. It is not possible to prepare flexible budget without making this distinction.

Need for Marginal Costing

Fixed expenses remain constant in aggregate amount and do not vary with the increase or decrease in production upto a particular level of output. Just contrary to this variable expenses increase or decrease in proportion to increase or decrease in output and remain constant per unit of output. Fixed expenses per unit continue to vary with the increase or decrease in production because these expenses remain constant upto a certain level of production. Thus, fixed overheads lead to different costs per unit at different levels of production. On account of this, a special technique known as marginal costing has been developed which excludes fixed overheads entirely from cost of production and gives us the same cost per unit upto a particular level of output. Thus, under this technique fixed expenses are not allocated to cost units but are charged against "fund" which arises out of excess of selling price over total variable costs.

Meaning of Marginal Cost

The Chartered Institute of Management Accountants, London, defines the term 'marginal cost' as follows :

Marginal Cost is the amount at any given volume of output by which aggregate costs are changed if the volume of output is increased or decreased by one unit. In this context a unit may be a single article, a batch of articles, an order, a stage of production capacity or a department. It relates to the change in output in the particular circumstances under consideration.

For example, if variable costs per unit are Rs. 10 and fixed expenses are Rs. 1,50,000 per annum, an output of 30,000 units per annum results in the following expenditure :

	Rs.
Variable cost of 30,000 units @ Rs. 10	= 3,00,000
Fixed cost	= 1,50,000
Total cost	= 4,50,000

If output is increased by one unit, the following expenditure will be incurred :

	Rs.
Variable cost of 30,001 units @ Rs. 10	$= 3,00,010$
Fixed costs	$= 1,50,000$
	Total cost
Less : Total cost for output of 30,000 units	$4,50,010$
Marginal cost of 1 unit	10

Meaning of Marginal Costing

According to CIMA Terminology *Marginal Costing* is the ascertainment of marginal costs and of the effect on profit of changes in volume or type of output by differentiating between fixed costs and variable costs. In this technique of costing only variable costs are charged to operations, processes or products, leaving all indirect costs to be written off against profits in the period in which they arise.

It is clear from the above that only variable costs form part of product cost in the technique of marginal costing because only variable costs are changed if output is increased or decreased and fixed costs remain the same.

Marginal costing is different from direct costing. *Direct costing* is the practice of charging all direct costs to operations, processes or products, leaving all indirect costs to be written-off against profit in the period in which they arise. Thus, in direct costing some fixed costs could be considered to be direct costs in appropriate circumstances but fixed cost is never taken in marginal cost.

Features of Marginal Costing

The following are the main features of Marginal Costing :

- (i) It is a technique of costing which is used to ascertain the marginal cost and to know the impact of variable cost on the volume of output.
- (ii) All costs are classified into fixed and variable cost on the basis of variability. Even semi fixed is segregated into fixed and variable cost.
- (iii) Variable cost alone are charged to production. Fixed costs are recovered from contribution.
- (iv) Valuation of stock of work in progress and finished goods is done on the basis of marginal cost.
- (v) Selling price is based on marginal cost plus contribution.
- (vi) Profit is calculated by deducting marginal cost and fixed cost from sales.
- (vii) Cost Volume Profit (or Break Even) Analysis, is one of the integral part of marginal costing.
- (viii) The profitability of a product/department is based on contribution made available by each product/department.

From the above, it is to be noted carefully that there are two aspects which require detailed treatment. These are :

1. Ascertainment of Marginal Cost.
2. Cost Volume Profit (or Break Even) Analysis.

These will be discussed in detail one by one.

Ascertainment of Marginal Cost

Ascertainment of marginal cost is different from total or absorption cost. In marginal cost it is assumed that the difference between the aggregate sales value and the aggregate marginal cost of the output sold provides a fund to meet the fixed cost and profit of the firm. In respect of each product, the difference between its sales value and the marginal cost is known as "contribution" made by the product to this fund. This contribution is the difference between the sale value and the marginal cost of sales and it contributes towards fixed expenses and profit.

Contribution can be represented as :

$$\text{Contribution} = \text{Selling Price} - \text{Marginal Cost}$$

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

$$\text{Contribution} - \text{Fixed Expenses} = \text{Profit}$$

If more than one products are produced, contribution of all products are merged into the fund out of which fixed expenses are deducted to get the figure of the profit. The following diagram represents a firm manufacturing three products and shows how individual product contributions are merged into the fund, the total amount of which should be sufficient to meet the fixed expenses and provide the desired profit.

<i>Product A</i>	<i>Product B</i>	<i>Product C</i>
Total sales value (Rs. 2,00,000)	Total sales value (Rs. 1,00,000)	Total sales value (Rs. 3,00,000)
minus	minus	minus
Marginal (or variable) cost of goods sold (Rs. 1,50,000)	Marginal (or variable) cost of goods sold (Rs. 80,000)	Marginal (or variable) cost of goods sold (Rs. 2,20,000)
Yields Contribution (Rs. 50,000)	Yields Contribution (Rs. 20,000)	Yields Contribution (Rs. 80,000)
	Fund (Rs. 1,50,000)	
	minus	
	Fixed Expenses (Rs. 1,00,000)	
	leaves	
	Profit (Rs. 50,000)	

ILLUSTRATION 2. The Himalayan House Ltd. is a large retailer in manufacturing equipment. The company's profit and loss account for the year ended 31st March, 2006 is given below :

	Rs.
Sales	24,00,000
<i>Less : Cost of goods manufactured (variable)</i>	<u>15,00,000</u>
Gross Margin (or Contribution)	9,00,000
<i>Less : Operating Expenses :</i>	Rs.
Selling Expenses	3,00,000
Administration Expenses	<u>1,50,000</u>
	4,50,000
Net Profit	4,50,000

The selling expenses are 90% variable and the administration expenses are 20% variable. You are required to prepare income statement under the marginal costing.

SOLUTION

INCOME STATEMENT *for the year ended 31st March, 2006*

	Rs.
Sales	24,00,000
<i>Less : Variable cost :</i>	
Cost of goods manufactured	15,00,000
Variable selling expenses	2,70,000
Variable administration expenses	<u>30,000</u>
	18,00,000
Contribution	6,00,000
<i>Less : Fixed cost :</i>	
Fixed selling expenses	30,000
Fixed administration expenses	<u>1,20,000</u>
	1,50,000
Net Profit	4,50,000

Advantages of Marginal Costing

The following are the main advantages of marginal costing :

- (1) It is simple to understand and easy to operate.
- (2) The valuation of closing stock under marginal costing is done at marginal cost and thus prevents the illogical carry forward of fixed costs of one period to the next one as part of value of closing stock.
- (3) There is no problem of computing fixed overhead recovery rates and their under or over recovery as fixed overheads are charged against the contribution.
- (4) In marginal costing, it is established that profit is a function of sale and not of production as profit depends on sales volume and not on production volume. This can be verified by preparing a profit statement under marginal costing.
- (5) It facilitates control over variable costs by avoiding arbitrary apportionment or allocation of fixed costs.
- (6) It is a very useful tool of profit planning. It guides the management about the profitability of earning profit at various levels of production and sales.
- (7) It is very valuable technique in decision-making. It provides information to management in making-decisions like make or buy, selling price fixation, export decision etc.
- (8) It provides the management with useful techniques like break even analysis, P/V ratio etc.
- (9) It helps in cost control by concentrating on variable cost as the fixed cost is non-controllable in the short period.
- (10) It helps in evaluation of performance of different departments, divisions and salesmen.
- (11) It is a valuable adjunct to standard costing and budgetary costing.

Limitations (or Disadvantages) of Marginal Costing

Marginal costing technique has certain limitations which must be kept in mind while making use of this technique.

1. The separation of expenses into fixed and variable presents certain technical difficulties whereas marginal costing technique assumes that all expenses can be divided into fixed and variable. In fact, no variable cost is completely variable and no fixed cost is completely fixed. Actually, most of the expenses are semi-variable and it is difficult to segregate them into fixed and variable.
2. Time taken for the completion of jobs is not given due attention because marginal cost excludes fixed expenses which are connected with time. Fixed expenses should be considered if the suitable comparison of two jobs is to be made.
3. With the development of technology, fixed expenses have increased and their impact on production is much more than that of variable expenses. So, a system of costing which ignores fixed expenses is less effective because a significant portion of the cost representing fixed expenses is not taken care of.
4. It is possible that a concern using marginal costing technique may value work-in-progress and finished stock at marginal cost. The arguments against valuing these items at marginal costs are as follows :
 - (a) Balance Sheet will not exhibit a true and fair view because work-in-progress and finished stock will be shown at marginal costs which do not include fixed expenses. Thus, finished stock and work-in-progress will be understated in the Balance Sheet.
 - (b) In case of loss by fire, full loss on account of stock destroyed by fire cannot be recovered from the insurance company because marginal costing technique of valuation of stock will not take fixed expenses into consideration.
5. Marginal costing technique does away with the difficulties involved in the apportionment of overheads because fixed expenses are deducted from total contribution. But the problem of apportionment of variable costs still arises.
6. Marginal costing technique is difficult to apply in contract or shipbuilding industry where the value of work-in-progress is high in relation to turnover. If fixed expenses are not included in the valuation of work-in-progress, losses may occur every year till the contract is completed, while on the completion of the contract there may be huge profits.

- | | |
|---|---|
| <p>6. Apportionment of fixed expenses on an arbitrary basis gives rise to over or under absorption of overheads which ultimately makes the product cost inaccurate and unreliable.</p> <p>7. Absorption costing is not very helpful in taking managerial decisions such as whether to accept the export order or not, whether to buy or manufacture, the minimum price to be charged during the depression etc.</p> <p>8. Costs are classified according to functional basis such as production cost, office and administrative cost and selling and distribution cost.</p> <p>9. Absorption costing fails to establish relationship of cost, volume and profit as costs are seldom classified into fixed and variable.</p> | <p>6. Only variable costs are charged to products, marginal cost technique does not lead to over or under absorption of fixed overheads.</p> <p>7. Technique of marginal costing is very helpful in taking managerial decisions because it takes into consideration the additional cost involved only assuming fixed expenses remaining constant.</p> <p>8. Costs are classified according to the behaviour of costs i.e., fixed costs and variable costs.</p> <p>9. Cost, Volume and Profit (i.e., CVP) relationship is an integral part of marginal cost studies as costs are classified into fixed and variable costs.</p> |
|---|---|

Marginal Cost Equation

For the sake of convenience, elements of costs can be written in the form of an equation as follows :

$$\text{Sales} = \text{Variable Cost} + \text{Fixed Expenses} \pm \text{Profit/Loss}$$

$$\text{Or Sales} - \text{Variable Costs} = \text{Fixed Expenses} \pm \text{Profit/Loss}$$

Or $S - V = F \pm P$ where 'S' stands for sales, V for variable costs, F for fixed expenses, + P for profit and - P for loss.

Or $S - V = C$ because $F \pm P$, i.e., Fixed Expenses + Profit/Loss = Contribution.

In order to make profit, contribution must be more than the fixed expenses and to avoid any loss, contribution must be equal to the fixed expenses.

Marginal cost equation of $S - V = F \pm P$ is very useful to find any of the four factors, i.e., S, V, F or P if three of these factors are known.

ILLUSTRATION 4. Determine the amount of fixed expenses from the following particulars :

Sales Rs. 2,40,000 ; Direct Materials Rs. 80,000 ; Direct Labour Rs. 50,000 ; Variable Overheads Rs. 20,000 and Profit Rs. 50,000.

SOLUTION

The Marginal Cost Equation is

$$S - V = F + P$$

$$S \text{ or Sales} = \text{Rs. } 2,40,000$$

$$V \text{ or Variable Costs} = \text{Rs. } 80,000 + \text{Rs. } 50,000 + \text{Rs. } 20,000 = \text{Rs. } 1,50,000$$

(Direct Materials + Direct Labour + Variable Overheads)

$$P \text{ or Profit} = \text{Rs. } 50,000$$

$$F \text{ or Fixed Expenses} = ? \text{ (not given)}$$

Applying the figures in the equation, we get

$$\text{Rs. } 2,40,000 - \text{Rs. } 1,50,000 = F + \text{Rs. } 50,000$$

$$\text{Or } \text{Rs. } 2,40,000 - \text{Rs. } 1,50,000 - \text{Rs. } 50,000 = F$$

$$\text{Or } \text{Rs. } 40,000 = F$$

$$\therefore \text{Fixed Expenses} = \text{Rs. } 40,000.$$

Break Even (or Cost-Volume-Profit) Analysis

Break even analysis is a logical extension of marginal costing. It is based on the same principles of classifying the operating expenses into fixed and variable. Now-a-days it has become a powerful instrument in the hands of policy makers to maximise profits.

There may be change in the level of production due to many reasons, such as competition, introduction of a new product, trade depression or boom, increased demand for the products, scarce

resources, change in the selling prices of products, etc. In such cases management must study the effect on profit on account of the changing levels of production. A number of techniques can be used as an aid to management in this respect. One such technique is the break even analysis.

The term 'break even analysis' is interpreted in the narrower as well as broader sense. Used in its *narrower sense*, it is concerned with finding out the break even point, i.e., level of activity where the total cost equals total selling price. Used in its *broader sense*, it means that system of analysis which determines the probable profit at any level of production. The break even analysis establishes the relationship of costs, volume and profit ; so this analysis is also known as 'Cost-Volume-Profit Analysis'.

Objectives of Cost-Volume-Profit Analysis

There exists close relationship between the cost, volume and profit. If volume is increased, the cost per unit will decrease and profit per unit will increase. Thus there is direct relation between volume and profit but inverse relation between volume and cost. Analysis of this relationship has become interesting and useful for the cost and management accountant. This analysis may be applied for profit-planning, cost control, evaluation of performance and decision making. The main objectives of such analysis are given below :

(i) This analysis helps to forecast profit fairly accurately as it is essential to know the relationship between profits and costs on one hand and volume on the other.

(ii) This analysis is useful in setting up flexible budgets which indicates costs at various levels of activity. We know that sales and variable costs tend to vary with the volume of output. It is necessary to budget the volume first for establishing budgets for sales and variable costs.

(iii) This analysis assists in evaluation of performance for the purpose of control. In order to review profits achieved and costs incurred, it is necessary to evaluate the effects on costs of changes in volume.

(iv) This analysis also assists in formulating price policies by showing the effect of different price structures on costs and profits. We are aware that pricing plays an important part in stabilizing and fixing up volumes especially in depression period.

(v) This analysis helps to know the amount of overhead costs to be charged to the products cost at various levels of operation as we know that pre-determined overhead rates are related to a selected volume of production.

The study of cost volume profit relationship can be made by (i) mathematical relationship between cost, volume and profit and (ii) by preparing break even charts.

In order to understand mathematical relationship between cost, volume and profit, it is desirable to understand the following four concepts, their calculation and applications.

- (i) Contribution
- (ii) Contribution/Sales (C/S) or Profit/Volume (P/V) Ratio
- (iii) Break Even Point
- (iv) Margin of Safety.

Contribution

Contribution is the difference between the sales and the marginal cost of sales and it contributes towards fixed expenses and profit. Suppose selling price per unit is Rs. 15, variable cost per unit Rs. 10, fixed cost Rs. 1,50,000, then contribution per unit will be Rs. 5 (selling price – marginal cost i.e., Rs. 15 – Rs. 10). Contribution for 30,000 units @ Rs. 5 is Rs. 1,50,000 which is sufficient only to meet the fixed costs of Rs. 1,50,000 and no amount is left for profit. If output is 20,000 units, contribution is Rs. 1,00,000 (i.e., 20,000 × Rs. 5) which is not sufficient to meet fixed expenses of Rs. 1,50,000 and the result is a loss of Rs. 50,000. An output of 40,000 units will give a contribution of Rs. 2,00,000 (i.e., 40,000 × Rs. 5) which will be sufficient to meet fixed costs of Rs. 1,50,000 and leave a profit of Rs. 50,000. Thus, contribution will first go to meet fixed expenses and then to earn profit. Contribution can be represented as :

$$\begin{aligned} \text{Contribution} &= \text{Selling Price} - \text{Marginal Cost} \\ \text{or} \quad \text{Contribution} &= \text{Fixed Expenses} + \text{Profit} \\ \text{or} \quad \text{Contribution} - \text{Fixed Expenses} &= \text{Profit} \end{aligned}$$

Difference Between Contribution and Profit

Contribution is different from the profit which is the net gain in activity or the surplus and remains after deducting fixed expenses from the total contribution. The following are the main differences between Contribution and Profit :

<i>Contribution</i>	<i>Profit</i>
(i) Includes fixed cost and profit.	(i) Does not include fixed cost.
(ii) Based on marginal cost concept.	(ii) Based on common man concept.
(iii) Contribution above break even point contributes to profit.	(iii) Profit is expected only after covering variable and fixed costs.
(iv) Contribution analysis requires a knowledge of break even concept.	(iv) Profit does not require any such concept.

In marginal costing, contribution is very important as it helps to find out the profitability of a product, department or division, to have better product mix, for profit planning and to maximise the profits of a concern.

Contribution/Sales (C/S) or Profit/Volume (P/V) Ratio

Profit/volume ratio is one of the most important ratios for studying the profitability of operations of a business and establishes the relationship between contribution and sales. This ratio is calculated as under :

$$\begin{aligned}
 \text{P/V Ratio} &= \frac{\text{Contribution}}{\text{Sales}} \left(\text{i.e., } \frac{C}{S} \right) \\
 \text{Or} &= \frac{\text{Fixed Expenses + Profit}}{\text{Sales}} \left(\text{i.e., } \frac{F + P}{S} \right) \\
 \text{Or} &= \frac{\text{Sales - Variable Costs}}{\text{Sales}} \left(\text{i.e., } \frac{S - V}{S} \right) \\
 \text{Or} &= \frac{\text{Change in Profits or Contributions}}{\text{Change in Sales}}
 \end{aligned}$$

Ratio can also be shown in the form of a percentage if the formula is multiplied by 100.

Thus, if selling price is Rs. 15 and the marginal cost is Rs. 10 then P/V ratio

$$= \frac{\text{Rs. } 15 - \text{Rs. } 10}{\text{Rs. } 15} = \frac{5}{15} = \frac{1}{3} \quad \text{or} \quad \frac{1 \times 100}{3} = 33\frac{1}{3}\%.$$

In the above example, for every Rs. 100 of sales, contribution is $33\frac{1}{3}\%$. A sale of every Rs. 100 will bring a profit of Rs. $33\frac{1}{3}$ after fixed expenses are met. Comparison of P/V ratios for different products can be made to find out which product is more profitable. Higher the P/V ratio, more will be the profit and lower the P/V ratio, lesser will be the profit. Hence, it should be the goal of every concern to increase or improve the P/V ratio. It can be done by :

- (a) Increasing the selling price per unit ;
- (b) Reducing direct and variable costs by effectively utilising men, machines and materials ;
- (c) Switching the production to more profitable products showing a higher P/V ratio.
- (d) Reducing the share of low margin products in the total sales and increasing the share of high margin products.

P/V ratio is very useful and is used for the calculation of :

$$(i) \text{ Break Even Point} = \frac{\text{Fixed Costs (i.e. FC)}}{\text{P/V Ratio}}$$

(ii) Value of sales to earn a desired amount of profit :

$$\frac{\text{Fixed Costs + Desired Profit}}{\text{P/V Ratio}}$$

- (iii) Variable Costs = Sales (1 - P/V Ratio)
- (iv) Profit = (Sales × P/V Ratio) - Fixed Cost
- (v) Fixed Cost = (Sales × P/V Ratio) - Profit
- (vi) Margin of Safety = $\frac{\text{Profit}}{\text{P/V Ratio}}$

ILLUSTRATION 5. Calculate P/V Ratio from the following information :

Given : Selling price Rs. 10 per unit, Variable cost per unit Rs. 6.

Given the profits and sales of two periods as under :

	<i>Sales</i>	<i>Profits</i>
	Rs.	Rs.
2005	1,50,000	20,000
2006	1,70,000	25,000

SOLUTION

$$(i) \text{ P/V Ratio} = \frac{\text{Contribution}}{\text{Sales}} \times 100 = \frac{\text{Rs. } 4}{\text{Rs. } 10} \times 100 = 40\%$$

$$\text{Contribution} = \text{S.P.} - \text{V.C. i.e., Rs. } 10 - \text{Rs. } 6 = \text{Rs. } 4$$

$$(ii) \text{ P/V Ratio} = \frac{\text{Change in Profit}}{\text{Change in Sales}} \times 100 = \frac{\text{Rs. } 5,000}{\text{Rs. } 20,000} \times 100 = 25\%$$

Even Point

A business is said to break even when its total sales are equal to its total costs. It is a point of no loss. At this point, contribution is equal to fixed cost. A concern which attains break point at less number of units will definitely be better from another concern where break even is achieved at more units of production.

The break even point can be calculated by the following formula :

Break Even Point (in units)

$$\begin{aligned} &= \frac{\text{Total Fixed Expenses}}{\text{Selling Price per unit} - \text{Marginal Cost per unit}} \\ &= \frac{\text{Total Fixed Expenses}}{\text{Contribution per unit}} \end{aligned}$$

Cash Break Even Point

$$= \frac{\text{Cash Fixed Cost}}{\text{Contribution per unit}}$$

Even Point Based on Total Sales

Marginal cost equation is :

$$S - V = F \pm P$$

Or $S - V = F + \text{Nil}$ (at break even point profit is nil)

For BEP, the equation is :

$$S - V = F$$

$$\text{Or } \frac{S - V}{S - V} = \frac{F}{S - V} \text{ (dividing both sides by } S - V)$$

$$\text{Or } 1 = \frac{F}{S - V}$$

$$\text{Or } S \times 1 = \frac{F \times S}{S - V} \text{ (multiplying both sides by } S)$$

∴ Formula for the calculation of break even sales is : $\frac{F \times S}{S - V}$ or $\frac{\text{Fixed Cost}}{\text{P/V Ratio}}$

ILLUSTRATION 6. From the following particulars calculate (i) Contribution (ii) P/V Ratio (iii) Break even point in units and in rupees. (iv) What will be the selling price per unit if the break even point is brought down to 25,000 units ?

	Rs.
Fixed Expenses	1,50,000
Variable Cost per unit	10
Selling Price per unit	15

SOLUTION

$$(i) \text{ Contribution} = \text{Selling Price per unit} - \text{Variable Cost per unit} \\ = \text{Rs. } 15 - \text{Rs. } 10 = \text{Rs. } 5.$$

$$(ii) \text{ P/V Ratio} = \frac{\text{Contribution}}{\text{Sales}} \times 100 = \frac{\text{Rs. } 5}{\text{Rs. } 15} \times 100 = 33\frac{1}{3}\%$$

$$(iii) \text{ Break even point (in units)} = \frac{\text{Fixed Expenses}}{\text{Contribution per unit}} = \frac{\text{Rs. } 1,50,000}{\text{Rs. } 5} = 30,000 \text{ units.}$$

$$\text{Break even points (in rupees)} = \frac{\text{Fixed Expenses}}{\text{P/V Ratio}} = \frac{\text{Rs. } 1,50,000}{33\frac{1}{3}\%} = \text{Rs. } 4,50,000.$$

$$(iv) \text{ Break even point (in units)} = \frac{\text{Fixed Expenses}}{\text{Contribution per unit}}$$

$$\text{Or Contribution per unit} = \frac{\text{Fixed Expenses}}{\text{Break even point (in units)}} = \frac{\text{Rs. } 1,50,000}{25,000} = \text{Rs. } 6.$$

$$\text{Selling price} = \text{Variable cost} + \text{Contribution per unit} \\ = \text{Rs. } 10 + \text{Rs. } 6 = \text{Rs. } 16.$$

Calculation of Output or Sales Value at which a Profit is Earned

Formula for the calculation of output to earn a certain amount (target) of profit is as follows :

$$\frac{\text{Fixed Expenses} + \text{Desired Profit}}{\text{Selling Price per unit} - \text{Marginal Cost per unit}}$$

$$\text{Or } \frac{\text{Fixed Expenses} + \text{Desired Profit}}{\text{Contribution per unit}}$$

$$\text{Or } \frac{\frac{\text{Target Profit}}{\text{Income Tax rate}}}{\text{Fixed Expenses} + \frac{\text{Contribution per unit}}{\text{Contribution per unit}}}$$

The formula for the calculation of sales value to earn a certain amount of profit is $\frac{(F + P)S}{S - V}$. It is derived as follows :

The marginal cost equation is :

$$S - V = F + P$$

Multiplying both sides by S, we get

$$(S - V)S = (F + P)S$$

$$\text{Or } S = \frac{(F + P)S}{S - V}$$

$$\text{Or Sales to earn a profit} = \frac{(F + P)S}{S - V} \text{ or } \frac{F + P}{\text{P/V Ratio}}$$

ILLUSTRATION 7. From the following data, calculate :

(i) Break even point expressed in amount of sales in rupees.

(ii) Number of units that must be sold to earn a profit of Rs. 1,20,000 per year.

- (iii) How many units are to be sold to earn a net income of 15% of sales ?
 (iv) Number of units to be sold to earn a target profit of Rs. 1,05,000 after income tax.
 (Assume Income Tax Rate to be 50%)

	Rs.
Selling Price per unit	40
Variable Manufacturing Cost per unit	22
Variable Selling Cost per unit	3
Fixed Factory Overheads	1,60,000
Fixed Selling Cost	20,000

SOLUTION

- (i) Break Even Point (in units)

$$\begin{aligned} &= \frac{\text{Fixed Expenses}}{\text{Selling Price per unit} - \text{Marginal Cost per unit}} \\ &= \frac{\text{Rs. } 1,60,000 + \text{Rs. } 20,000}{\text{Rs. } 40 - \text{Rs. } 25} = \frac{\text{Rs. } 1,80,000}{\text{Rs. } 15} = 12,000 \text{ units.} \end{aligned}$$

(Marginal Cost = Variable Manufacturing Cost + Variable Selling Cost)

$$\begin{aligned} \text{Break Even Point (In Sales value)} &= \text{Break even units} \times \text{Selling price per unit} \\ &= 12,000 \times \text{Rs. } 40 = \text{Rs. } 4,80,000. \end{aligned}$$

- (ii) Output to earn a profit of Rs. 1,20,000 :

$$\begin{aligned} &= \frac{\text{Fixed Expenses} + \text{Profit}}{\text{Selling Price per unit} - \text{Marginal Cost per unit}} \\ &= \frac{\text{Rs. } 1,80,000 + \text{Rs. } 1,20,000}{\text{Rs. } 40 - \text{Rs. } 25} = \frac{\text{Rs. } 3,00,000}{\text{Rs. } 15} = 20,000 \text{ units} \end{aligned}$$

- (iii) Suppose Number of units to be sold = N.

$$\begin{aligned} N &= \frac{\text{Fixed Cost} + \text{Desired Profit}}{\text{Contribution per unit}} \\ N &= \frac{\text{Rs. } 1,80,000 + \frac{15}{100} (N \times \text{Rs. } 40)}{\text{Rs. } 15} \end{aligned}$$

$$15N = 1,80,000 + 6N$$

$$\text{or } 9N = 1,80,000$$

$$N = 20,000 \text{ units.}$$

$$\begin{aligned} \text{(iv) Sales in units} &= \frac{\text{Target Profit}}{\text{Fixed Cost} + \frac{\text{Income Tax Rate}}{\text{Contribution per unit}}} \\ &= \frac{\text{Rs. } 1,80,000 + \frac{\text{Rs. } 1,05,000}{1 - .5}}{\text{Rs. } 15} \\ &= \frac{\text{Rs. } 3,90,000}{15} = 26,000 \text{ units} \end{aligned}$$

ILLUSTRATION 8. M Ltd. manufactures three products P, Q and R. The unit selling prices of these products are Rs. 100, Rs. 80 and Rs. 50 respectively. The corresponding unit variable costs are Rs. 50, Rs. 40 and Rs. 20. The proportions (quantity-wise) in which these products are manufactured and sold are 20%, 30% and 50% respectively. The total fixed costs are Rs. 14,80,000.

Given the above information, you are required to work out the overall break-even quantity and the product-wise break up of such quantity.

SOLUTION**CALCULATION OF BREAK EVEN QUANTITY**

	Products			Overall
	P	Q	R	
	Rs.	Rs.	Rs.	
Selling price per unit	100	80	50	
Less : Variable cost per unit	50	40	20	
Contribution per unit	50	40	30	
Quantity-wise proportion of the products manufactured and sold	20% Rs. 10 (50 × 20%)	30% Rs. 12 (40 × 30%)	50% Rs. 15 (30 × 50%)	Rs. 37
Weighted Contribution Margin (Contribution × Proportion of Quantity)				Rs. 14,80,000 40,000 units
Total Fixed Costs				($\frac{\text{Rs. } 14,80,000}{\text{Rs. } 37}$)
Overall Break Even Quantity				40,000 units
$\left(\frac{\text{Total Fixed Cost}}{\text{Overall Contribution Margin}} \right)$				
Production-wise Break Even Quantity	8,000 units	12,000 units	20,000 units	
(Total Break Even Quantity × Proportion)	(40,000 × 20%)	(40,000 × 30%)	(40,000 × 50%)	

ILLUSTRATION 9. Sale of a product amounts to 1,000 units per annum at Rs. 500 per unit. Fixed overheads are Rs. 1,00,000 per annum and variable cost Rs. 300 per unit. There is a proposal to reduce the price by 20%. Calculate present and future P/V ratio and break even point (in units). How many units must be sold to maintain total profit?

SOLUTION

	Present Position	After price reduction
	Rs.	Rs.
Selling Price per unit	500	400
Less : Variable Cost per unit	300	300
Contribution per unit	200	100
P/V Ratio		
$\frac{\text{Contribution}}{\text{Sales}} \times 100$	$\frac{200}{500} \times 100 = 40\%$	$\frac{100}{400} \times 100 = 25\%$ Break
$= \frac{\text{Fixed Cost}}{\text{Contribution per unit}}$	Even Point (in units) $\frac{\text{Rs. } 1,00,000}{\text{Rs. } 200} = 500 \text{ units}$	$\frac{\text{Rs. } 1,00,000}{\text{Rs. } 100} = 1,000 \text{ units}$
Present Profit = Contribution – Fixed Cost	$200 \times 1,000 - 1,00,000$ = Rs. 1,00,000	Fixed Cost + Profit Contribution per unit $= \frac{\text{Rs. } 1,00,000 + \text{Rs. } 1,00,000}{\text{Rs. } 100}$ = 2,000 units
Units to be sold to maintain total profit		

ILLUSTRATION 10. An analysis of costs of Sullivan Manufacturing Company led to the following information :

Cost Elements	Variable Costs (Percentage of Sales)	Fixed Costs Rs.
Direct Materials	32.8	
Direct Labour	28.4	
Factory Overheads	12.6	1,39,900
Distribution Expenses	4.1	58,400
General and Administrative Expenses	1.1	66,700

Budgeted sales for the next year are Rs. 18,50,000.

You are required to determine—

- (i) the break-even sales volume,
- (ii) the profit at the budgeted sales volume,
- (iii) the profit, if actual sales—
 - (a) drop by 10 per cent.
 - (b) increase by 5 per cent from budgeted sales.

(CS—Inter)

SOLUTION

Percentage of variable cost to sales is 79% calculated as follows :

Direct Materials	32.8% of sales
Direct Labour	28.4% of sales
Factory Overheads	12.6% of sales
Distribution Expenses	4.1% of sales
General and Administrative Expenses	1.1% of sales
Total Variable Cost	<u>79% of sales</u>

$$\therefore \text{Percentage of Contribution to Sales} = 100 - 79 = 21$$

(Contribution = Sales – Variable Cost)

$$\text{P/V Ratio (Profit/Volume Ratio)} = \frac{\text{Contribution}}{\text{Sales}} = \frac{21}{100} \text{ or } 21\%$$

(i) Break Even Sales Volume

$$\begin{aligned} &= \frac{\text{Fixed Costs}}{\text{P/V Ratio}} = \frac{\text{Rs. } 1,89,900 + \text{Rs. } 58,400 + \text{Rs. } 66,700}{21/100} \\ &= \text{Rs. } 3,15,000 \times \frac{100}{21} = \text{Rs. } 15,00,000 \end{aligned}$$

(ii) Profit at the budgeted sales of Rs. 18,50,000

Percentage of Contribution to Sales = 21

∴ Contribution at the budgeted sales of Rs. 18,50,000

$$= \text{Rs. } 18,50,000 \times \frac{21}{100} = \text{Rs. } 3,88,500$$

$$\begin{aligned} \text{Profit} &= \text{Contribution} - \text{Fixed Expenses} \\ &= \text{Rs. } 3,88,500 - \text{Rs. } 3,15,000 = \text{Rs. } 73,500. \end{aligned}$$

(iii) (a) Profit if actual sales drop by 10%

	Rs.
Budgeted Sales	18,50,000
Less : 10% Decline	<u>1,85,000</u>
Actual Sales	<u>16,65,000</u>
Contribution @ 21% of sales = $\text{Rs. } 16,65,000 \times \frac{21}{100}$	3,49,650
Less : Fixed Expenses	<u>3,15,000</u>
Profit	<u>34,650</u>

(b) Profit if actual sales increase by 5% from budgeted sales

	Rs.
Budgeted Sales	18,50,000
Add : 5% increase	<u>92,500</u>
Actual Sales	<u>19,42,500</u>
Contribution @ 21% on Sales = $\frac{\text{Rs. } 19,42,500 \times 21}{100}$	4,07,925
Less : Fixed Expenses	<u>3,15,000</u>
Profit	<u>92,925</u>

ILLUSTRATION 11. The fixed costs amount to Rs. 1,50,000 and the percentage of variable costs to sales is given to be $66\frac{2}{3}\%$. If 100% capacity sales at normal are Rs. 9,00,000, find out the break even point and the percentage sales when it occurs. Determine profit at 80% capacity sales.

SOLUTION

Percentage of variable costs to sales is $66\frac{2}{3}\%$ i.e., $\frac{200}{3}$

$$\text{Percentage of contribution to sales is } 100 - \frac{200}{3} = \frac{100}{3}$$

$$\text{P/V Ratio} = \frac{\text{Contribution}}{\text{Sales}} = \frac{100}{3} \times \frac{1}{100} = \frac{1}{3} \text{ or } \frac{1}{3} \times 100 = 33\frac{1}{3}\%$$

$$\text{B.E.P.} = \frac{\text{Fixed Expenses}}{\text{P/V Ratio}} = \text{Rs. } \frac{1,50,000}{1/3} = 1,50,000 \times \frac{3}{1} = \text{Rs. } 4,50,000$$

100% Capacity Sales = Rs. 9,00,000

$$\therefore \text{B.E.P. occurs at } \frac{\text{Rs. } 4,50,000}{\text{Rs. } 9,00,000} \times 100 = 50\%$$

Profit at 80% capacity sales :

100% Capacity Sales Rs. 9,00,000

$$\therefore 80\% \text{ Capacity Sales } 9,00,000 \times \frac{80}{100} = \text{Rs. } 7,20,000.$$

	Rs.
Variable costs at 80% capacity sales ($66\frac{2}{3}\%$ of Rs. 7,20,000)	4,80,000
Fixed Costs	1,50,000
Total Cost	6,30,000
Sales	<u>7,20,000</u>
Profit at 80% capacity sales	<u>90,000</u>

Margin of Safety

Margin of safety is the difference between the actual sales and the sales at break even point. One of the assumptions of marginal costing is that output will coincide sales, so margin of safety is also the excess production over the break even point's output. Sales or output beyond break even point is known as margin of safety because it gives some profit, at break even point only fixed expenses are recovered. Margin of safety can also be expressed in percentage. For example, if present sales are Rs. 4,00,000 and break even sales are Rs. 3,00,000, margin of safety is Rs.

1,00,000 i.e., $\text{Rs. } 4,00,000 - \text{Rs. } 3,00,000$ or $25\% \left(\text{i.e. } \frac{\text{Rs. } 1,00,000}{\text{Rs. } 4,00,000} \times 100 \right)$. Thus, formula for the calculation of margin of safety is :

$$\text{Margin of Safety (M/S)} = \text{Present Sales} - \text{Break Even Sales}$$

Margin of Safety can also be calculated with the help of the following formula :

$$\text{Margin of Safety (M/S)} = \frac{\text{Profit}}{\text{P/V Ratio}}$$

Margin of safety is that sales or output which is above break even point. All fixed expenses are recovered at break even point ; so fixed expenses have been excluded from the formula of margin of safety given above. Margin of safety is that sales which gives us profit after meeting fixed costs ; so formula of its calculation takes only profit.

If the margin of safety is large, it is an indicator of the strength of a business because with a substantial reduction in sales or production, profit shall be made. On the other hand, if the margin is small, a small reduction in sales or production will be a serious matter and lead to loss. The margin of safety at break even point is nil because actual sales volume is just equal to the break even sales.

Efforts should be made by the management to increase (or improve) the margin of safety so that more profit may be earned. This margin can be increased by taking the following steps :

- (i) Increase the level of production. (Sales volume) provided the capacity is available.
- (ii) Increase the selling price.
- (iii) Reduce the fixed or the variable costs or both.
- (iv) Substitute the existing products by more profitable products.

ILLUSTRATION 12. A company has fixed expenses of Rs. 90,000 with sales at Rs. 3,00,000 and a profit of Rs. 60,000 during the first half year. If in the next half year, the company suffered a loss of Rs. 30,000, Calculate :

- (a) The P/V ratio, break even point and margin of safety for the first half year.
- (b) Expected sales volume for next half year assuming that selling price and fixed expenses remain unchanged.
- (c) The break even point and margin of safety for the whole year.

SOLUTION

$$(a) \text{ P/V Ratio} = \frac{\text{Contribution}}{\text{Sales}} \times 100 = \frac{\text{Rs. } 1,50,000}{\text{Rs. } 3,00,000} \times 100 = 50\%$$

$$\text{Break Even Point} = \frac{\text{Fixed Cost}}{\text{P/V Ratio}} = \frac{\text{Rs. } 90,000}{50\%} = \text{Rs. } 1,80,000.$$

$$\begin{aligned} \text{Margin of Safety} &= \text{Actual Sales} - \text{Break Even Sales} = \text{Rs. } 3,00,000 - \text{Rs. } 1,80,000 \\ &= \text{Rs. } 1,20,000. \end{aligned}$$

$$(b) \text{ Expected Sales Volume} = \frac{\text{Fixed Cost} - \text{Loss}}{\text{P/V Ratio}} = \frac{\text{Rs. } 90,000 - \text{Rs. } 30,000}{50\%} \\ = \text{Rs. } 1,20,000.$$

$$(c) \text{ Break Even Point (for the whole year)} = \frac{\text{Fixed cost for the whole year}}{\text{P/V Ratio}} \\ = \frac{\text{Rs. } 1,80,000}{50\%} = \text{Rs. } 3,60,000.$$

$$\begin{aligned} \text{Margin of Safety} &= \text{Actual Sales} - \text{Break Even Sales} = \text{Rs. } 4,20,000 - \text{Rs. } 3,60,000 \\ &= \text{Rs. } 60,000. \end{aligned}$$

ILLUSTRATION 13. Assuming that the cost structure and selling prices remain the same in Periods I and II, find out :

(a) Profit Volume Ratio ;

(b) Fixed Cost ;

(c) Break Even Point for Sales ;

(d) Profit when Sales are of Rs. 1,00,000 ; $1,00,000 / 40\% = 250,000$

(e) Sales required to earn a Profit of Rs. 20,000 ; $20,000 / 40\% = 50,000$

(f) Margin of Safety at a profit of Rs. 15,000 ; $20,000 - 50,000 = 35,000$

(g) Variable cost in Period II

Period	Sales	Profit
	Rs.	Rs.
I	1,20,000	9,000
II	1,40,000	13,000

SOLUTION

$$(a) \text{ P/V Ratio} = \frac{\text{Change in Profits}}{\text{Change in Sales}} \times 100 = \frac{\text{Rs. } 4,000}{\text{Rs. } 20,000} \times 100 = 20\%$$

$$(b) \text{ Fixed Cost} = (\text{Sales} \times \text{P/V Ratio}) - \text{Profit} = \text{Rs. } \left(1,20,000 \times \frac{1}{5} \right) - \text{Rs. } 9,000 \\ = \text{Rs. } 24,000 - \text{Rs. } 9,000 = \text{Rs. } 15,000.$$

$$(c) \text{ Break Even Point (in rupees)} = \frac{\text{Fixed Cost}}{\text{P/V Ratio}} = \frac{\text{Rs. } 15,000}{20\%} = \text{Rs. } 75,000.$$

$$(d) \text{ Profit} = (\text{Sales} \times P/V \text{ Ratio}) - \text{Fixed Cost} = \left(1,00,000 \times \frac{1}{5}\right) - \text{Rs. } 15,000 = \text{Rs. } 5,000.$$

$$(e) \text{ Sales} = \frac{\text{Fixed Cost} + \text{Desired Profit}}{P/V \text{ Ratio}} = \frac{\text{Rs. } 15,000 + \text{Rs. } 20,000}{20\%} = \text{Rs. } 1,75,000.$$

$$(f) \text{ Margin of Safety} = \frac{\text{Profit}}{P/V \text{ Ratio}} = \frac{\text{Rs. } 15,000}{20\%} = \text{Rs. } 75,000.$$

$$(g) \text{ Variable Cost in Period II} = (1 - P/V \text{ Ratio}) \times \text{Sale}$$

$$= \frac{80}{100} \times \text{Rs. } 1,40,000 = \text{Rs. } 1,12,000.$$

ILLUSTRATION 14. The profit volume (P/V) ratio of B B & Co. dealing in precision instruments is 50% and the margin of safety is 40%.

You are required to work out the break-even point and the net profit if the sale volume is Rs. 50 lakhs.

SOLUTION

Calculation of Sales at Break-even Point

Sales	Rs. 50,00,000
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Less : Margin of Safety 40% $\left(i.e. \text{Rs. } 50,00,000 \times \frac{40}{100}\right)$	20,00,000
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Sales at Break Even Point	30,00,000
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P/V Ratio	50%
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Therefore, Contribution or Fixed Expenses at

B.E.P. (50% of Rs. 30,00,000)	Rs. 15,00,000
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Calculation of Net Profit at Sales Volume of Rs. 50,00,000

Contribution on Rs. 50,00,000 Sales	Rs.
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$\left(\text{Sales} \times P/V \text{ Ratio i.e., Rs. } 50,00,000 \times \frac{50}{100}\right)$	25,00,000
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Less : Fixed Expenses	15,00,000
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Profit	10,00,000
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ILLUSTRATION 15. Comment on the economic soundness of the following firms :

	<i>Firm A</i>	<i>Firm B</i>
	Rs.	Rs.
Current Sales Volume	3,00,000	3,00,000
Break Even Sales Volume	2,00,000	2,00,000
Margin of Safety	1,00,000	1,00,000
Fixed Cost	1,00,000	60,000

SOLUTION

	<i>Firm A</i>	<i>Firm B</i>
	Rs.	Rs.

Break Even Sales	2,00,000	2,00,000
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Fixed Cost or Contribution	1,00,000	60,000
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(At B.E.P. Contribution is equal to Fixed Cost)	50%	30%
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P/V Ratio $\left(i.e. \frac{\text{Contribution}}{\text{Sales}} \times 100\right)$	$\left(\frac{1,00,000}{2,00,000} \times 100\right)$	$\left(\frac{60,000}{2,00,000} \times 100\right)$
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Absorption Costing and Marginal Costing

	Rs.	Rs.
Current Sales Volume	3,00,000	3,00,000
Contribution on Current Sales Volume (i.e., Sales \times P/V Ratio)	1,50,000 $(3,00,000 \times 50\%)$	90,000 $(3,00,000 \times 30\%)$
Less : Fixed Cost	1,00,000	60,000
Profit	<u>50,000</u>	<u>30,000</u>

Comment : Firm A is more sound as compared to Firm B because it gives excess profit of Rs. 20,000 (i.e., Rs. 50,000 – Rs. 30,000). It is because of higher P/V ratio of 50%. Higher the P/V ratio, the better it is. Firm A will start earning profit @ 50% on sales after B.E.P. whereas firm B will earn profit @ 30% on sales in excess of break even sales.

Effect of Price Reduction on P/V Ratio, B.E. Point and Margin of Safety

In order to see the effect of certain changes on P/V ratio, breakeven point and margin of safety, the following data is assumed :

	<i>Original</i>	<i>After 10% increase</i>
No. of Units Produced & Sold	8,000	8,800
Unit Seiling Price	Rs. 20	Rs. 22
Unit Variable Cost	Rs. 10	Rs. 11
Total Fixed Costs	Rs. 40,000	Rs. 44,000
		I
Contribution	Rs. 10 (Rs. 20 – Rs. 10)	Rs. 22 – Rs. 10 = Rs. 12
		II
		Rs. 20 – Rs. 11 = Rs. 9

	<i>Present Solution</i>	<i>Increase in per unit selling price</i>	<i>Increase in per unit variable cost</i>	<i>Increase in total fixed costs</i>	<i>Increase in no. of units sold</i>
P/V ratio = Contribution Sales	$\frac{\text{Rs. } 10}{\text{Rs. } 20} \times 100$ = 50%	$\frac{\text{Rs. } 12}{\text{Rs. } 22} \times 100 =$ 54.55%	$\frac{9}{20} \times 100$ = 45%	No effect	No effect
Break Even Point = Fixed Costs P/V Ratio	$\frac{\text{Rs. } 40,000}{50\%}$ = Rs. 80,000	$\frac{\text{Rs. } 40,000}{6}$ $\frac{11}{11}$ = Rs. 73,333	$\frac{\text{Rs. } 40,000}{45\%}$ = Rs. 88,889	$\frac{\text{Rs. } 40,000}{50\%}$ = Rs. 88,000	No effect
Margin of Safety = Total Sales – BEP Sales	Rs. 1,60,000 – Rs. 80,000 = Rs. 80,000	Rs. 1,76,000 – Rs. 73,333 = Rs. 1,02,667	Rs. 1,60,000 – Rs. 88,889 = Rs. 71,111	Rs. 1,60,000 – Rs. 88,000 = Rs. 72,000	$(8,800 \times \text{Rs. } 20) - \text{Rs. } 80,000 =$ Rs. 1,76,000 – Rs. 80,000 = Rs. 96,000

From the above it is clear that if

- (i) there is increase in selling price per unit it will increase the P/V ratio reduce the break even point and increase the margin of safety. If there is reduction in price per unit, it will decrease the P/V ratio, increase the break even point and shorten the margin of safety.
- (ii) there is increase in variable cost per unit, it will decrease the P/V ratio, increase the break even point and shorten the margin of safety.
- (iii) there is increase in total fixed costs, there will no effect on P/V ratio, increase the break even point and shorten the margin of safety.
- (iv) there is increase in no. of units sold, it will have no effect on P/V ratio and break even point but will increase the margin of safety.

ILLUSTRATION 16. The selling price of a product was Rs. 200 per unit, as against its variable cost of Rs. 100 per unit. The total fixed costs were Rs. 2,00,000. Calculate the effect of a reduction in price by Rs. 40 on the P/V Ratio, Break Even Point and Margin of Safety, if 4,000 units were produced and sold.

SOLUTION

	<i>Before Price Reduction</i>	<i>After Price Reduction</i>
	Rs.	Rs.
Selling Price per unit	200	160
Less : Variable cost per unit	100	100
Contribution per unit	100	60
Total Fixed Cost	Rs. 2,00,000	Rs. 2,00,000
P/V Ratio $\left[\frac{\text{Contribution}}{\text{Sales}} \times 100 \right]$	$\frac{100}{200} \times 100 = 50\%$	$\frac{60}{160} \times 100 = 37.5\%$
Break Even Point		
	$\left[\frac{\text{Fixed Cost}}{\text{P/V Ratio}} \right]$	
	$\frac{2,00,000}{50\%}$	$\frac{2,00,000}{37.5\%}$
	= Rs. 4,00,000	= Rs. 5,33,333
Total Sales	$4,000 \times \text{Rs. } 200$	$4,000 \times \text{Rs. } 160$
	= Rs. 8,00,000	= Rs. 6,40,000
Margin of Safety	$\text{Rs. } 8,00,000 - \text{Rs. } 4,00,000$	
= (Total Sales - Break even Sales)	= Rs. 4,00,000	= Rs. 6,40,000 - Rs. 5,33,333
		= Rs. 1,06,667

From the above, it is clear that effect of price reduction is always to reduce P/V ratio, to raise the break even point and to shorten the margin of safety.

↗ BREAK EVEN CHART

A break-even chart is a graphical representation of marginal costing. It is considered to be one of the most useful graphic presentation of accounting data. It is a readable reporting device that would otherwise require voluminous reports and tables to make the accounting data meaningful to the management. This chart shows the inter-relationship between cost, volume and profit. It shows the break-even point and also indicates the estimated cost and estimated profit or loss at various volumes of activity. There are three methods of drawing a break-even chart. These have been explained with the help of the following Illustration :

ILLUSTRATION 17. From the following data, calculate the break even point and profit if output is 50,000 units by drawing a break even chart.

<i>Production</i>	<i>Fixed Expenses</i>	<i>Variable Cost per unit</i>	<i>Selling Price per unit</i>	<i>Total Cost</i>	<i>Total Sales</i>
(Units)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
0	1,50,000	10	15	1,50,000	0
10,000	1,50,000	10	15	2,50,000	1,50,000
20,000	1,50,000	10	15	3,50,000	3,00,000
30,000	1,50,000	10	15	4,50,000	4,50,000
40,000	1,50,000	10	15	5,50,000	6,00,000
50,000	1,50,000	10	15	6,50,000	7,50,000
60,000	1,50,000	10	15	7,50,000	9,00,000

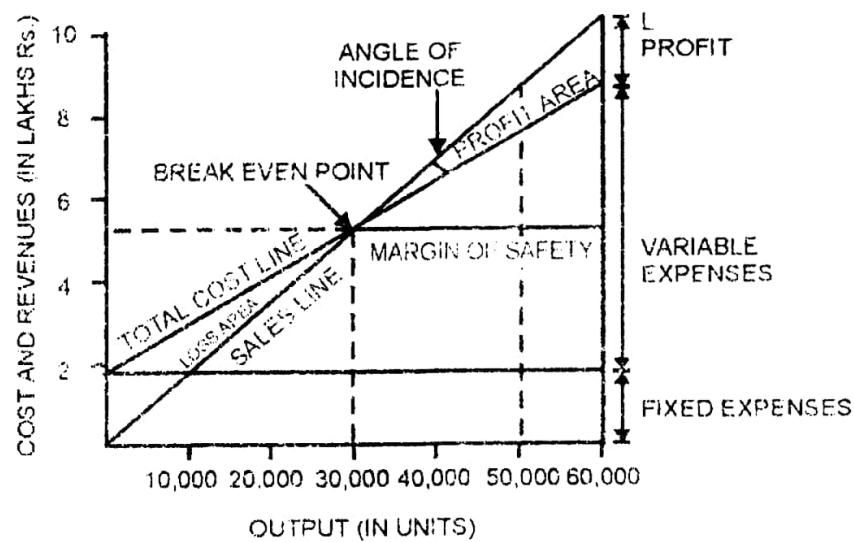
SOLUTION

First Method. On the X-axis of the graph is plotted the number of units produced, sold and on the Y-axis are shown costs and sales revenues.

The fixed cost line is drawn parallel to X-axis. This line indicates that fixed expenses remain the same with any volume of production. The variable costs for different levels of activity are plotted over the fixed cost line. The variable cost line is joined to fixed cost line at zero volume of production. This line can also be regarded as the total cost line because it starts from the point where fixed cost has been incurred and variable

cost is zero. Sales values at various levels of output are plotted, joined and the resultant line is the sales line. The sales line will cut the

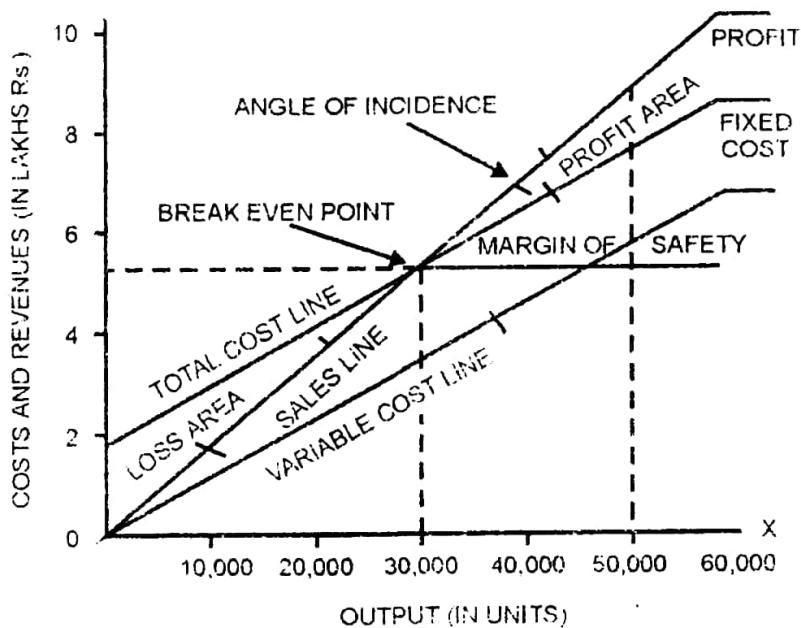
BREAK EVEN CHART



total cost line at a point where the total costs are equal to total revenues and this point of intersection of two lines is known as break even point—the point of no profit no loss. The number of units to be produced at the break even point is determined by drawing a perpendicular to the X-axis from the point of intersection and measuring the horizontal distance from the zero point to the point at which the perpendicular is drawn. The sales value at break even point is determined by drawing a perpendicular to the Y-axis from the point of intersection and measuring the vertical distance from the zero point to the point at which the perpendicular is drawn. Loss and profit are as have been shown in the chart which show that if production is less than the break even point, the business shall be running at a loss and if the production is more than the break even level, profit shall result.

Second Method. A variation of the first method is that variable cost line is plotted first and then fixed cost line over the variable cost line. The latter line is the total cost line because it is drawn over the variable cost line and represents the total cost (variable and fixed) at various levels of output. This method is more helpful to the management for decision making because it shows the recovery of fixed costs at various levels of production before profits are realised. Contributions at various levels of production are automatically disclosed in the chart.

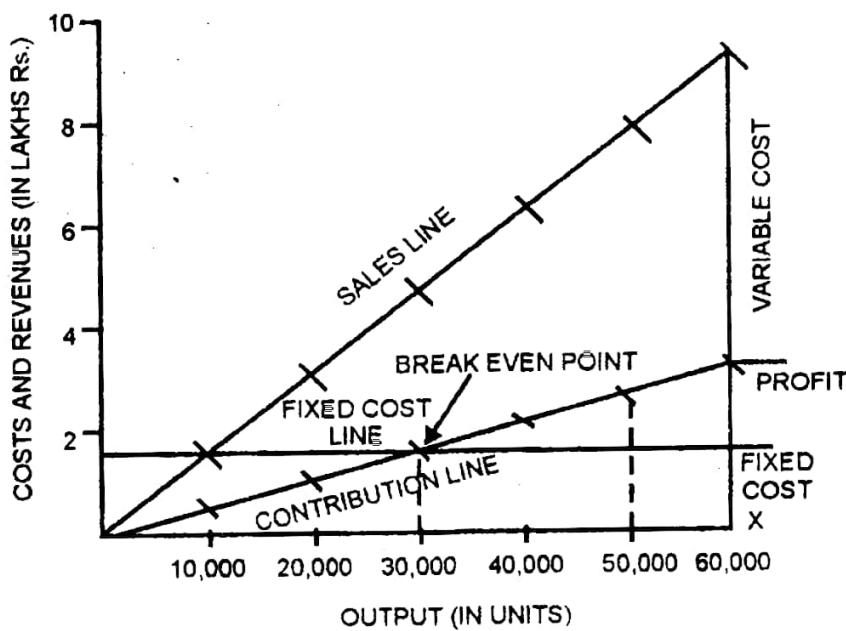
BREAK EVEN CHART



Third Method. Under this method, the fixed cost line is drawn parallel to the X-axis. The contribution line is drawn from the origin and this line goes up with the increase in output. The sales line is plotted as usual. The question of interaction of sales line with cost line does not arise because the total cost line is not

drawn in this method. In this method, break even point is that point where the contribution line cuts the fixed cost line. At this point, contribution is equal to fixed expenses and there is no profit no loss.

BREAK EVEN CHART



If the contribution is more than the fixed expenses, profit shall arise and if the contribution is less than the fixed expenses, loss shall arise. In this example there is a profit of Rs. 1,00,000 when the output is 50,000 units. At this level of output, contribution is Rs. 2,50,000 (i.e., 50,000 units @ Rs. 5), and fixed cost is Rs. 1,50,000, resulting in a profit of Rs. 1,00,000, i.e., contribution minus fixed cost.

Arithmetical Verification

$$\text{Break Even Point} = \frac{\text{Fixed Expenses}}{\text{Contribution per unit}} = \frac{\text{Rs. } 1,50,000}{\text{Rs. } 5} = 30,000 \text{ units of output}$$

or $30,000 \text{ units} \times \text{Selling price}$
 $= 30,000 \times \text{Rs. } 15 = \text{Rs. } 4,50,000 \text{ sales}$

Profit when the output is 50,000 units	=	Rs. 2,50,000
Contribution for 50,000 units @ Rs. 5	=	Rs. 1,50,000
<i>Less : Fixed Expenses</i>	=	<u>Rs. 1,00,000</u>
Profit	=	

Angle of Incidence

This is the angle formed at the break even point at which the sales line cuts the total cost line. This angle indicates *rate at which profits are being made*. Large angle of incidence is an indication that profits are being made at a high rate. On the other hand, a small angle indicates a low rate of profit and suggests that variable costs form the major part of cost of production. A large angle of incidence with a high margin of safety indicates the most favourable position of a business and even the existence of monopoly conditions.

Relationship between Angle of Incidence, Break even Sales and Margin of Safety

When break even sales are very low, with large angle of incidence, it indicates that the firm is enjoying business stability and in that case margin of safety sales will also be high.

When break even sales are low, but not very low with moderate angle of incidence, in that case, though the business is stable, the profit earning rate is not very high as in earlier case.

Contrary to above, when break even sales are high, angle of incidence will be narrow with much low margin of safety sales.

Assumptions Underlying Break Even Chart

1. All costs can be separated into fixed and variable costs.
2. Fixed costs will remain constant and will not change with the change in level of output.

3. Variable costs will fluctuate in the same proportion in which the volume of output varies. In other words, prices of variable cost factors i.e., wage rates, price of material etc. will remain unchanged.
4. Selling price will remain constant even though there may be competition or change in volume of production.
5. The number of units produced and sold will be the same so that there is no opening or closing stock.
6. There will be no change in operating efficiency.
7. There is only one product or in the case of many products, product mix will remain unchanged.
8. Product specifications and methods of manufacturing and selling will not change.

Advantages of Break Even Charts

1. Information provided by the break even chart can be understood by the management more easily than contained in the Profit and Loss Account and the Cost Statements because a break even chart is the simple presentation of cost, volume and profit structure of the company. It summarises a great mass of detailed information in a graph in such a way that its significance may be grasped even with a cursory glance.
2. A break even chart is useful for studying the relationship of cost, volume and profit. The chart is very useful for taking managerial decisions because it shows the effect on profits of changes in fixed costs, variable costs, selling price and volume of sales.
3. The chart is very useful for forecasting costs and profits at various volumes of sales.
4. A break even chart is a tool for cost control because it shows the relative importance of the fixed costs and the variable costs.
5. Profitability of various products can be studied with the help of these charts and a most profitable product mix can be adopted. Profits at different levels of activity can also be ascertained.
6. The profit potentialities can be best judged from a study of the position of the break even point and the angle of incidence in the break even chart. Low break even point and large angle of incidence in the break even chart indicate that fixed costs are low and margin of safety is high. It is a sign of financial stability. In such a case, some monopolistic conditions prevail and high profits are earned over a large range of production activity. Low break even point and small angle of incidence show that fixed costs are low and margin of safety is high, but rate of profit is not high because of absence of monopolistic conditions. High break even point and large angle of incidence show that fixed costs are high and margin of safety is low. A small fall in volume may put the business into losses and a small increase in volume may give a high profit because of large angle of incidence. Last, high break even point and small angle of incidence is the worst position because it indicates a low margin of safety and a low rate of profit.
7. It is helpful in the determination of sale price which would give desired profits or a B.E.P.
8. It is helpful in knowing the effect of increase or reduction in selling price.

Limitations

1. A break even chart is based on a number of assumptions (discussed earlier) which may not hold good. Fixed costs vary beyond a certain level of output. Variable costs do not vary proportionately if the law of diminishing or increasing returns is applicable in the business. Sales revenues do not vary proportionately with changes in volume of sales due to reduction in selling price as a result of competition or increased production.

In the break even chart, we have seen that the total cost line and the sales line look straight lines. This is possible only with a number of assumptions. But, in practice, the total cost line and the sales line are not straight lines because the assumptions do not hold good. Thus, there might be several break even points at different levels of activity.

2. A limited amount of information can be shown, in a break even chart. A number of charts will have to be drawn up to study the effects of changes in fixed costs, variable costs and selling prices.
3. The effect of various product mixes on profits cannot be studied from a single break even chart.

4. A break even chart does not take into consideration capital employed which is a very important factor in taking managerial decisions. Therefore, managerial decisions on the basis of break even chart may not be reliable.

In spite of the above limitations, the break even chart is a useful management device for analysing the problems, if it is constructed and used by those who fully understand its limitations.

Profit-Volume Graph

Profit-volume graph is a simplified form of break even chart and is an improvement over the break even chart as it clearly shows the relationship of profit to volume or sales. This graph suffers from the same limitations with which break even chart suffers. It is possible to construct a P/V graph for any data relating to a business from which a break even chart can be drawn. Construction of this graph is relatively simple and the procedure of construction is as follows :

(1) A scale for sales on horizontal axis is selected and other scale for profits and fixed cost or loss on the vertical axis is selected. The area below the horizontal axis is the 'loss area' and that above it is the 'profit area'.

(2) Points of profits of corresponding sales are plotted and joined. The resultant line is the profit/loss line.

Uses of P/V Graph

- (i) To determine break even point.
- (ii) To show impact on profits of selling profit at different prices for a product.
- (iii) To forecast costs and profits resulting from changes in sales volume.
- (iv) To show the deviations of actual profit from anticipated profit relative profitability under conditions of high or low demand.

Limitations of P/V Graph

- (i) It assumes that cost can be predicted at any level of activity and can be categorised into fixed and variable and their written behaviour at all levels, i.e., fixed costs always remain fixed and variable cost strictly vary with production.
- (ii) Assume constant selling price and the same pattern of sales amount of different products.
- (iii) Changes in inventory levels at the beginning and end will be insignificant.
- (iv) It assumes the same level of technology and the same level of efficiency.

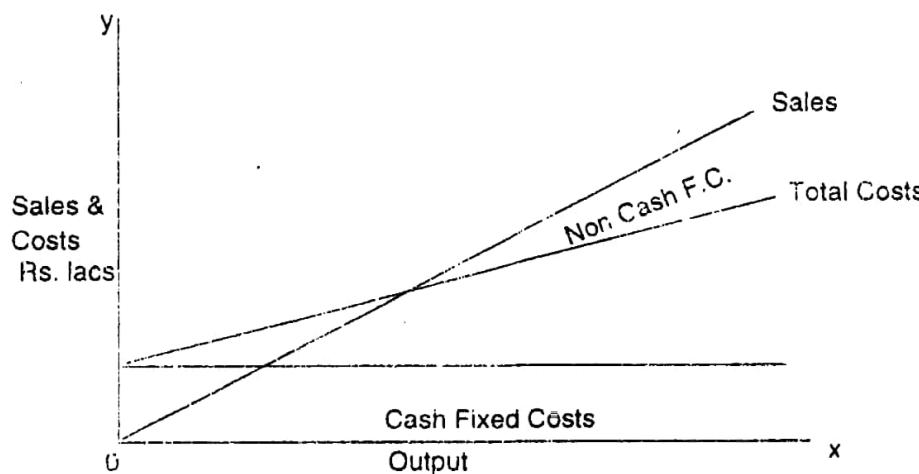
All these mean our simplification of actual state of affairs and to that extent the conclusions drawn are affected.

Cash Break Even Chart

While preparing cash break-even chart, only cash fixed costs are taken. Non-cash items like depreciation etc., are excluded from the fixed costs for computation of break-even point. Cash break-even chart depicts the level of output or sales at which the sales revenue will be equal to total cash outflow. It is computed as under :

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

The following is the diagrammatic representation of cash break-even chart :



TYPES OF INVESTMENT DECISIONS

Investment decisions may be classified into two groups as given below :

(1) When only one proposal of investment is under consideration. The simple decision to be taken in this case is *Accept-Reject Decision*. In such a case all investment proposals are independent of each other. In other words, there are no mutually exclusive proposals. For example, if the minimum acceptable rate of return after tax is 12% and investment under consideration is expected to give a rate of return of 15%, it should be accepted and if it is likely to give a return of 10% lower than the acceptable return of 12%, it should be rejected.

(2) When there are mutually exclusive proposals i.e. a number of alternative investments are competing for selection. In such a case, a ranking of profitability of various alternative investment proposals should be made and the alternative which gives maximum return should be given top priority. In case of mutually exclusive proposals, ranking is necessary for making a choice of the best alternative.

REPLACEMENT INVESTMENTS

According to **J. Batty**, "The objective of asset replacement is to enable an organisation to carry on exchanging goods in order to provide continuing satisfaction to all having relationship with the undertaking ; investors, employees, customers, suppliers, the government and the public. If we are to raise our standard of living there must be no wasteful capital expenditure, and there should be an increased selectivity in choosing expenditure which will promote the maximum return to all concerned."

Asset replacements can be of three types as given below :

Optional Replacement. When a fixed asset (e.g. plant) and its products are self-contained, an option is available when replacement is under consideration as to whether the plant and its product/products be discontinued. Plant will be replaced if it is beneficial to concern keeping in view its profit benefit of giving lower unit cost of output. The replacement will also be paying if the return is satisfactory compared to what is available before replacement.

Necessary Replacement. Replacement is necessary when a broken-down machine forming one part of a linked sequence of processes is to be replaced. Such type of replacement will have to be made even if the replacement of the machine increases the cost of one operation because other processes are going to be affected if replacement of machine is not made. Replacement made to meet legal requirements (e.g. replacement of a pollution control device) come under the category of necessary replacements.

Social Replacement. Welfare and amenities assets to be replaced come under this category. The objective of such type of assets is to provide amenities (e.g. better lighting, ventilation, heating, medical facilities etc.) to the work force working in the organisation. It is very difficult to measure the rate of return of such types of investments. The guiding principle is to keep the work force satisfied so that productivity may increase.

For evaluation of the replacement investment, the following two criteria are generally used .

1. Comparative Unit Cost of Output

By this method, the effect on unit cost of production as a result of replacement of asset is ascertained. If the unit cost after replacement is likely to come down, replacement of asset will be made for improving the profitability of the concern.

While ascertaining unit cost, some accountants are of the view that it is necessary to add to the cost of operation of new asset the portion of yearly loss of asset replaced, if any. It seems to be justified to add yearly loss of asset replaced when replacement is optional and not necessary. The amount of capital loss involved in replacement of old asset should be spread over the life of the new asset. But when replacement is compulsory due to competitive conditions or legal requirements, capital loss due to replacement of existing asset should be ignored and yearly loss of such capital loss should not be added to the cost of operation of new asset. The amount of capital loss should be treated as a sunk cost and should be written off to Financial Profit and Loss Account.

2. Average Additional Return on Investment

This method expresses the ratio of the average additional annual profits after taxes to the average investment in the project. Average rate of additional profit is calculated as follows :

$$\text{Average Rate of Additional Return} = \frac{\text{Average Annual Additional Profit (after Taxes)}}{\text{Average Investment}} \times 100$$

Here,

Average Annual Additional Profit =

Difference between the average annual profits arising out of sale of output produced by new machine and those produced by the machine proposed to be replaced.

Average Investment = $\frac{1}{2}$ of the depreciable cost of the proposed plant + residual value, if any.

If the additional return on investment is satisfactory, the replacement of the old asset with the new asset will be paying.

ILLUSTRATION 1. ABC Co. has a machine which has been in operation for six years. The management is considering a proposal to purchase an improved model of a similar machine which gives an increased output. Give your opinion as a Management Accountant in regard to the proposal from the following data :

	<i>Old Machine</i>	<i>New Machine</i>
	Rs.	Rs.
1. Purchase price of machine	90,000	1,80,000
2. Expenditure p.a. on account of :		
(i) Power consumption	10,500	12,000
(ii) Consumable stores	6,000	7,500
(iii) Repairs and maintenance	7,500	6,000
3. Labour cost per running hour	3	3.75
4. Units of output per hour	60	90
5. Machine running hours per annum	2,000	2,000
6. Material cost per unit	40 paise	40 paise
7. Selling price of output per unit	Re. 1.00	Re. 1.00
8. Estimated Life	10 years	10 years

Assume the rate of tax is 50%

SOLUTION

	<i>Old Machine</i>	<i>New Machine</i>
	Rs.	Rs.
Purchase Price	90,000	1,80,000
Estimated Life	10 years	10 years
Output per hour	60 units	90 units
Machine running hours per annum	2,000	2,000
Output per annum (units)	1,20,000	1,80,000
	$(2,000 \times 60)$	$(2,000 \times 90)$
	Rs.	Rs.
Selling price per unit	1.00	1.00

Sales per annum (Units × Selling Price)	1,20,000	1,80,000
<i>Less : Cost of Production</i>		
Material	48,000	72,000
Wages	6,000	7,500
Power	10,500	12,000
Consumable Stores	6,000	7,500
Repairs and Maintenance	7,500	6,000
Depreciation (10%)	9,000	18,000
	87,000	1,23,000
<i>Profit before tax</i>	33,000	57,000
<i>Less : 50% Tax</i>	16,500	28,500
<i>Profit after tax</i>	16,500	28,500

Average Additional Profit per annum (Rs. 28,500 - Rs. 16,500) = Rs. 12,000

Average Annual Additional Return on Investment

$$= \frac{\text{Average Annual Additional Profit}}{\text{Average Investment}} \times 100 = \frac{\text{Rs. } 12,000}{\text{Rs. } 90,000} \times 100 = 13.33\%$$

$$\text{Average Investment} = \frac{\text{Cost of New Machine}}{2} = \frac{\text{Rs. } 1,80,000}{2} = \text{Rs. } 90,000$$

The new machinery will give an additional annual return of 13.33% which is considered to be a good return. Therefore, the new machinery should be purchased.

New Investment Criteria

The methods employed for ascertainment of profitability of new investments are as follows :

1. Average Rate of Return.
2. Payback Method.
3. Internal Rate of Return Method.
4. Present Value Method.
5. Profitability Index.
6. Terminal Value Method.

1. Average Rate of Return or Accounting Rate of Return

This method represents the ratio of the average annual profits after taxes to the average investment in the project. Average rate of return is calculated as follows :

$$\text{Average Rate of Return} = \frac{\text{Average Annual Profits (After Taxes)}}{\text{Average Investment in the Project}} \times 100$$

For example, the purchase price of the new machine is Rs. 96,000, and it will require additional amount of Rs. 9,000 to install, bringing the total cost to Rs. 1,05,000. The old machine to be replaced can be sold for its depreciated book value of Rs. 5,000. The initial net cash outflow for the machine, therefore, is Rs. 1,00,000 (Rs. 96,000 + Rs. 9,000 - Rs. 5,000). The new machine is expected to earn Rs. 10,000 a year after taxes for the next five years, after which it is not to be used, nor is it expected to have a salvage value. The average net-investment in the machinery,

assuming straight line depreciation, is Rs. 50,000 $\left(\frac{\text{Rs. } 1,00,000}{2} \right)$.

Therefore, average rate of return is :

$$\frac{\text{Rs. } 10,000}{\text{Rs. } 50,000} \times 100 \left(\frac{\text{Average Annual Profits after Taxes}}{\text{Average Investment}} \times 100 \right) = 20\%.$$

The average rate of return method is sometimes based upon the original investment rather than the average investment. In the above example, the average rate of return then

would be 10% (i.e., $\frac{\text{Rs. } 10,000}{\text{Rs. } 1,00,000} \times 100$).

The most important advantage of this method is its simplicity because it makes use of readily available accounting information. It is simple to calculate and takes into consideration benefits over the entire life of the project. Once the average rate of return is calculated, it becomes easy to make a comparison with the return required by investors at the margin to determine whether a particular proposal for capital expenditure should be accepted or rejected.

The principal drawbacks of the method are that it is based upon accounting income ratios rather than upon cash flows. It does not take into consideration the timing of cash inflows and outflows. The method ignores the present value of future earnings of the proposed project ; profits in the later years are valued the same as profits in the first year. A profit of Rs. 10,000 in the fifth year is equal to Rs. 10,000 in the first year. Hence, this method can lead to a wrong evaluation of the comparative worth of the competing projects. A project which gives profit only after the fifth year

existence can have the same rate of return as another project which starts giving profit in the first year of its existence. Timing of cash inflows is a crucial factor which must be considered capital budgeting decisions.

The alternative names for the average rate of return (*i.e.*, ARR) are "Accounting Rate of Return" and "Return on Capital Employed."

ILLUSTRATION 2. Calculate the accounting rate of return for the following investment:

<i>Year</i>	<i>Cash Flow</i> Rs.
0	(1,50,000)
1	21,000
2	60,000
3	1,05,000
4	75,000

Life of the investment is four years. There is no scrap value at the end of 4 years.

SOLUTION

Cost of the investment Rs. 1,50,000
Life 4 years

$$\text{Depreciation per year} = \frac{\text{Rs. } 1,50,000}{4} = \text{Rs. } 37,500$$

Calculation of Accounting Rate of Return

<i>Year</i>	<i>Cash Inflow</i>	<i>Depreciation</i>	<i>Accounting Income (Cash Inflow-Depreciation)</i>
	Rs.	Rs.	Rs.
1	21,000	37,500	(16,500) (<i>i.e., Loss</i>)
2	60,000	37,500	22,500
3	1,05,000	37,500	67,500
4	75,000	37,500	37,500
Total Accounting Income for 4 years			1,11,000

$$\text{Average Accounting Income} = \frac{\text{Rs. } 111,000}{4} = \text{Rs. } 27,750$$

$$\text{Accounting Rate of Return} = \frac{\text{Average Accounting Income}}{\text{Cost of the Investment}} \times 100 = \frac{\text{Rs. } 27,750}{\text{Rs. } 150,000} \times 100 = 18.5\%$$

Alternative Solution

$$\text{Accounting Rate of Return} = \frac{\text{Average Accounting Income}}{\text{Average Investment}} \times 100 = \frac{\text{Rs. } 27,750}{\text{Rs. } 75,000} \times 100 = 37\%$$

$$(\text{Average Investment} = \frac{\text{Cost of the Investment}}{2} = \frac{\text{Rs. } 1.50,000}{2} = \text{Rs. } 75,000)$$

ILLUSTRATION 3. A limited company is considering the purchase of a machine. Two machines A and B are available. From the following information relating to the two machines, ascertain which of the two alternatives will be more profitable. The average rate of tax may be taken at 50%.

	<i>Machine A</i>	<i>Machine B</i>
Cost of each machine	Rs. 50,000	Rs. 80,000
Working life	4 years	6 years
Earnings before tax	Rs.	Rs.
Year I	10,000	8,000
Year II	15,000	14,000
" III	20,000	25,000
" IV	15,000	30,000
" V		15,000
" VI		15,000

SOLUTION

	Machine A	Machine B
	Rs.	Rs.
Total Net Profit (before tax)	60,000	1,08,000
Average Annual Profit (before tax)	15,000	18,000
	$(60,000 \div 4)$	$(1,08,000 \div 6)$
Average Annual Profit (after 50% tax)	7,500	9,000
Cost of Machine	50,000	80,000
Average Investment	25,000	40,000
	$(50,000 \div 2)$	$(80,000 \div 2)$
Average Annual Return on Investment	30%	22.5%
	$\left(\frac{7,500}{25,000} \times 100 \right)$	$\left(\frac{9,000}{40,000} \times 100 \right)$

Machine A gives the higher average return, so it is more profitable as compared to Machine B.

Note. Average annual return on investment is calculated as follows :

$$\frac{\text{Average Annual Profit (after Tax)}}{\text{Average Investment}} \times 100.$$

ILLUSTRATION 4. A job which is presently done entirely by manual methods has a labour cost of Rs. 46,000 a year. It is proposed to instal a machine to do the job which involves an investment of Rs. 80,000 and an annual operating cost of Rs. 10,000. Assume the machine can be written off in 5 years on straight-line depreciation basis for tax purposes. Salvage value at the end of its economic life is zero. The tax rate is 55%. Analyse economic implications of the proposal by the rate of return method.

SOLUTION

STATEMENT SHOWING THE ECONOMIC IMPLICATIONS OF THE PROPOSAL BY THE RATE OF RETURN METHOD

Manual labour per year under the existing method	Operating cost per year if machine is installed	Depreciation per year if the machine is installed	Total of operating cost and depreciation	Savings before tax	Tax @ 55%	Net Savings after tax per year
Rs. 46,000	Rs. 10,000	Rs. 16,000 $(80,000 \div 5)$	Rs. 26,000	Rs. 20,000 $(46,000 - 26,000)$	Rs. 11,000 $\left(20,000 \times \frac{55}{100} \right)$	Rs. 9,000 -12,000 --11,000

$$\text{Rate of Return on Investments (R.O.I.)} = \frac{\text{Net Savings per year}}{\text{Cost of Investment}} \times 100 = \frac{9,000}{80,000} \times 100 = 11.25\%.$$

The installation of the machine will give an additional return of 11.25% which is considered to be a good return. Therefore, labour should be replaced by the machine. As a rule, average cost of the investment should be considered to get better idea of the return. Average rate of return is calculated as follows :

$$\text{Average Rate of Return} = \frac{\text{Net savings per year}}{\text{Average cost of investment}} \times 100 = \frac{9,000}{40,000} \times 100 = 22.5\%$$

Average rate of return of 22.5% is a very good return, so no opportunity should be lost to replace the labour by the machinery.

2. Payback Method

The payback period of a fixed asset tells us the number of years required to recover the initial investment of that asset. This period is calculated by dividing the cost of the fixed asset by the annual savings in costs or additional earnings after tax but before depreciation. The payback period is calculated as follows :

$$\text{Pay Back Period} = \frac{\text{Cost of the Investment}}{\text{Savings or Additional Earnings after Tax but before Depreciation per year}}$$

$$= \frac{\text{Cost of the Investment}}{\text{Savings or Net Cash Inflow per year}}$$

The above formula of the payback is applicable if the saving or net cash inflow accrues at an even rate. But if the annual cash inflows are not equal, the job of calculation of the payback period is somewhat more difficult. Suppose, the cost of the investment is Rs. 50,000 and the annual savings in cost or additional earnings are Rs. 10,000 in the first year, Rs. 14,000 in the second year, Rs. 16,000 in the third year and Rs. 20,000 per year in the fourth and fifth years. In the first three years Rs. 40,000 (Rs. 10,000 + Rs. 14,000 + Rs. 16,000) of the original investment will be recovered and Rs. 10,000 balance of the investment will be recovered in the first half of the fourth year.

$$\text{Thus, the payback period in this case is } 3 \text{ years} + \frac{\text{Rs. } 10,000}{\text{Rs. } 20,000} = 3.5 \text{ years.}$$

In this connection another term known as *bailout payback time* deserves mention. Bailout payback time of a capital project is reached when its cumulative cash receipts plus its salvage value at the end of a particular year equal its initial investment.

This method is based on the idea that the original cost of the investment must be recovered if the company is to remain in effective existence. The best investment would be that which has the shortest payback period. The working life of the asset should be more than the payback period so that some profits may also be earned in addition to the recovery of the cost of the asset. The payback profitability of the investment can also be calculated by this method as follows :

$$\text{Payback Profitability} = \text{Saving or earnings per annum} / (\text{Working Life} - \text{Payback Period})$$

The payback period is somewhat similar to the break-even point. A business unit starts making profit after the break-even point is reached. Similarly, a capital project will make profit only if its life is more than the payback period.

The shorter is the payback period, the less risky is the investment, and the greater is its liquidity. The company that is financially tight up may find the method to be very useful in assessing the early recovery of the cost of the investment. In case of capital rationing or tight money position, a company is supposed to invest in projects having shortest payback period. The method is simple to understand and operate and shows the period within which the cost of the investment will be recovered. But this method does not take account of the magnitude or timing of cash flows during the payback period : it takes into consideration only the recovery period as a whole. A capital expenditure earning more profit at the beginning periods is more profitable than the one which earns more profit during later periods. This method does not give an idea of return on investment. Being so this method can be seen more a measure of liquidity than of profitability.

The payback method gives good results in industries where the risk of obsolescence is high. In the modern world where technological changes are taking place at a fast speed, this method has a great utility. The management must attempt to undertake only those projects which have a shorter payback period so as to recover all their investments at least before the change in technology makes the project obsolete. Thus, this method considers risks of obsolescence which may arise on account of technological changes, political instability, fashion goods and introduction of a new product. It can be concluded from the above discussion that this method is most useful when the future is very uncertain.

ILLUSTRATION 5. A company proposing to expand its production can go in either for an automatic machine costing Rs. 2,24,000 with an estimated life of $5\frac{1}{2}$ years or an ordinary machine costing Rs. 60,000 having an estimated life of 8 years.

The annual sales and costs are estimated as follows :

	Automatic Machine	Ordinary Machine
	Rs.	Rs.
Sales	1,50,000	1,50,000
Costs :		
Material	50,000	50,000
Labour	12,000	60,000
Variable Overhead	24,000	20,000

Compute the comparative profitability of the proposals under the payback method. Ignore income tax.

SOLUTION

	<i>Automatic Machine</i>	<i>Ordinary Machine</i>	
Sales per annum		Rs. 1,50,000	Rs. 1,50,000
Less : Variable Costs :			
Material	50,000	50,000	
Labour	12,000	60,000	
Variable Overhead	24,000	20,000	
	<hr/>	<hr/>	
	86,000		1,30,000
Earnings per year		64,000	<hr/>
		<hr/>	20,000
		2,24,000	<hr/>
		<hr/>	60,000
		64,000	<hr/>
Payback Period		$= 3\frac{1}{2}$ yrs.	20,000
$\left(\frac{\text{Cost of the Investment}}{\text{Earnings per year}} \right)$			$= 3$ yrs.

Payback Profitability = Earnings per annum (Working Life – Payback period)

Automatic Machine : Rs. 64,000 ($5\frac{1}{2}$ yrs. – $3\frac{1}{2}$ years) = Rs. 1,28,000

Ordinary Machine : Rs. 20,000 (8 yrs. – 3 yrs.) = Rs. 1,00,000

On consideration of the payback alone, the ordinary machine having a shorter payback period of 3 years should be recommended. But in the long run, the automatic machine which gives a surplus of Rs. 1,28,000 in $5\frac{1}{2}$ years would be preferable to the ordinary machine which gives a surplus of only Rs. 1,00,000 in 8 years. The difference in the results shows us the drawback of the payback method that it ignores the profit earned after the payback period is over.

ILLUSTRATION 6. ABC Co. Ltd., an engineering company, is considering the purchase of a new machine for its immediate expansion programme. There are three possible machines at the same cost, which are suitable for the purpose ; the details of these are given below together with the estimated costs and sales values.

	<i>Machines</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
	Rs.	Rs.	Rs.
Capital cost	3,00,000	3,00,000	3,00,000
Sales (at standard prices)	5,00,000	4,00,000	4,50,000
Net cost of production :			
Direct material	40,000	50,000	48,000
Direct labour	50,000	30,000	36,000
Factory overheads	60,000	50,000	58,000
Administrative costs	20,000	10,000	15,000
Selling and distribution costs	10,000	10,000	10,000

The economic life of Machine No. 1 is 2 years, while it is 3 years for the other two, after which they will have a scrap value of Rs. 40,000, Rs. 25,000 and Rs. 30,000 respectively.

Sales are expected to be at the rates shown for each year during the full economic life of the machines. The costs relate to the annual expenditure resulting from each machine.

Total tax to be paid is estimated at 45% of the net earnings each year. It may be assumed that all payables and receivables will be settled promptly, strictly on cash basis with no outstanding from one accounting year to another. Interest on capital should be considered at a uniform rate of 8% per annum.

You are required to show which machine would be the most profitable investment on the principle of 'payback method' (with net cash flow basis).

(All plausible assumptions made on arriving at the answer should be clearly stated).

SOLUTION

STATEMENT SHOWING PROFITABILITY OF 3 MACHINES

		Machine 1	Machine 2	Machine 3
		Rs.	Rs.	Rs.
Capital Cost		3,00,000	3,00,000	3,00,000
Sales	(1)	5,00,000	4,00,000	4,50,000
Direct Material		40,000	50,000	48,000
Direct Labour		50,000	30,000	36,000
Factory Overheads		60,000	50,000	58,000
Administrative Costs		20,000	10,000	15,000
Selling and Distribution Costs		10,000	10,000	10,000
Total Cost before Depreciation and Interest	(2)	1,80,000	1,50,000	1,67,000
Profit before Interest and Depreciation	(1) - (2)	3,20,000	2,50,000	2,83,000
Less : Depreciation $\left(\frac{\text{Cost} - \text{Scrap Value}}{\text{Economic life}} \right)$		1,30,000	91,667	90,000
Less : Interest (8% of Rs. 3,00,000 Capital Cost)		24,000	24,000	24,000
Profit before Tax		1,66,000	1,34,333	1,69,000
Less : Tax @ 45%		74,700	60,450	76,050
Profit after Tax		91,300	73,883	92,950
Add Back Depreciation and Interest being Non-cash Items		1,54,000	1,15,667	1,14,000
Net Cash Inflow		2,45,300	1,89,550	2,06,950
Payback Period = $\frac{\text{Capital Cost}}{\text{Net Cash Inflow}}$		1.22 yrs.	1.58 yrs.	1.45 yrs.
		(3,00,000)	(3,00,000)	(3,00,000)
		÷ 2,45,300	÷ 1,89,550	÷ 2,06,950

Machine No. 1 is most profitable because it takes minimum period of 1.22 years to recover the cost of the investment.

Assumptions

- (1) Factory overheads do not include depreciation.
- (2) Interest is not out of pocket cost.
- (3) No borrowings will be required for working capital.

ILLUSTRATION 7. From the following information, select the best project using (a) Payback period (b) Surplus life over payback period and (c) surplus cash flow, as the decision criterion :

	Project A	Project B	Project C
Cost (Rs.)	2,40,000	3,20,000	3,50,000
Life	10 years	12 years	14 years
Estimated scrap value (Rs.)	20,000	20,000	28,000
Annual Profit less Taxation (Rs.)	26,000	31,000	28,000

SOLUTION

Project A	Project B	Project C
Rs.	Rs.	Rs.
2,40,000	3,20,000	3,50,000
20,000	20,000	28,000
2,20,000	3,00,000	3,22,000

- Cost
- Less : Scrap value
- Value to be written off

Life (years)	10	12	14
Depreciation p.a. (Rs.)	22,000	25,000	23,000
(a) Evaluation on the Basis of Payback Period			
Annual Profit less Taxation	26,000	31,000	28,000
Add : Depreciation	22,000	25,000	23,000
Annual Cash Inflow	48,000	56,000	51,000
Payback Period = $\frac{\text{Cost of the Project}}{\text{Annual Cash Inflow}}$	5 Years	5.71 Years	6.86 Years
	$\left(\frac{\text{Rs. } 2,40,000}{\text{Rs. } 48,000} \right)$	$\left(\frac{\text{Rs. } 3,20,000}{\text{Rs. } 56,000} \right)$	$\left(\frac{\text{Rs. } 3,50,000}{\text{Rs. } 51,000} \right)$
Rank	I	II	III

Project A is the best project.

(b) Evaluation on the Basis of Surplus Life Over Payback Period

	Project A	Project B	Project C
Life	10 years	12 years	14 years
Less : Payback Period as per (a) above	5 years	5.71 years	6.86 years
Profitable Period	5 years	6.29 years	7.14 years
Rank	III	II	I

Higher the surplus life over payback period, better it is. On this basis project C is the best project.

(c) Evaluation on the Basis of Surplus Cash Flow

	Project A	Project B	Project C
	Rs.	Rs.	Rs.
Annual Profit less Taxation	26,000	31,000	28,000
Add : Depreciation being non-cash item written back	22,000	25,000	23,000
Annual Cash Inflow	48,000	56,000	51,000
Life of the Project	10 years	12 Years	14 Years
Total Cash Inflows for the Life of the Project	4,80,000	6,72,000	7,14,000
Less : Cost of the Project (Cash Outflow)	2,40,000	3,20,000	3,50,000
	2,40,000	3,52,000	3,64,000
Add : Scrap Value	20,000	20,000	28,000
Surplus Cash Flow	2,60,000	3,72,000	3,92,000
Rank	III	II	I

On the basis of surplus cash flow, project C is the best project because it gives the highest surplus cash flow.

3. Internal Rate of Return Method (IRR)

Because of the drawback of not taking account of the magnitude and the timing of cash flows in the average rate of return and payback methods, it is felt that discounted cash flow (i.e. DCF) methods provide a more objective basis for evaluating capital expenditure. These methods take into consideration the magnitude and the timing of expected earnings in each period of a project's life and discount the future earnings to the present value. The two discounted cash flow methods are the internal rate of return and the present value methods.

The internal rate of return for an investment proposal is the discount rate that equates the present value of initial cost of the investment with the present value of the expected net cash flows.

Mathematically, it is represented by the rate, r , such that :

$$A_0 = \frac{A_1}{(1+r)^1} + \frac{A_2}{(1+r)^2} + \dots + \frac{A_n}{(1+r)_n}$$

A_0 = Initial outlay at time 0

A_1, A_2, \dots, A_n = stream of future net cash flows.

SOLUTION

Suppose we start with four discount rates — 15%, 16%, 17% and 18% by trial and error method and calculate the present value of net cash flows. Using these discount rates, we find:

<i>1 Discount Rate</i>	<i>2 Discount Factor (Note from the table given)</i>	<i>3 Net Cash Flow each year</i>	<i>(4) Present Value of Cash Inflows (2) × (3)</i>
	Rs.	Rs.	Rs.
18%	3.1272	28,000	87,562
17%	3.1993	28,000	89,580
16%	3.2743	28,000	91,680
15%	3.3522	28,000	93,862

When we make comparison of the present value of cash inflows with the initial outlay of Rs. 90,000, we see that internal rate of return necessary to discount the cash inflows to Rs. 90,000, falls between 16% and 17% being closer to 17% than to 16%. To find out the actual rate, we interpolate between 16% and 17% as follows :

Discount Rate	Present Value of Cash Inflows
	Rs.
16%	91,680
17%	89,580
<hr/> Difference	<hr/>
1%	2,100

At 16% there is a difference of Rs. 1,680 from the initial outlay (Rs. 91,680 – Rs. 90,000). So to cover a difference of Rs. 1,680, we use additional discount of .8% ($\frac{\text{Rs. } 1,680}{\text{Rs. } 2,100}$). Thus the internal rate of return is $16\% + .8\% = 16.8\%$.

The proposal of investment should be accepted because the internal rate of return of 16.8% is more than the required rate of return of 10%.

4. Present Value Method (PV Method)

Like the internal rate of return method, the present value method is a discounted cash flow method. In this method all net cash inflows are discounted to present value using the required rate of return. Mathematically, the method can be expressed as follows :

$$V = \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \dots + \frac{C_n}{(1+r)^n}$$

Where,

V = Present value of net cash inflows.

C_1, C_2, \dots, C_n = Stream of future net cash flows after tax but before depreciation.

r = Required rate of return

1, 2, ..., n = Number of years.

If the present value of expected cash inflows exceeds the initial cost of the project, the project should be accepted. The net present value of the investment can also be calculated by deducting the initial cost of the investment from the present value of net cash inflows. If we are to select a project out of various alternative projects, the best project is that which has the highest net present value. This method lays emphasis on the comparison of net present value and disregards the initial investment involved. This method does not measure percentage return on investment. Present value of Re. 1 payable or receivable at the end of each period is given on next few pages.

COMPARISON BETWEEN INTERNAL RATE OF RETURN METHOD AND PRESENT VALUE METHOD

Both methods are discounted cash flow methods of evaluation of capital projects because they take into consideration the magnitude and the timing of expected earnings in each period of a project's life. The internal rate of return is the discount rate that equates the present value of initial cost of the investment with the present value of expected net cash flows. The present value

(Continued on page II/14.19)

Present value of Re. 1 payable or receivable at the end of each period is given on this & next 3 pages.

PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE ANNUALLY

at the end of each period

Year	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	Year
1	0.9901	0.9804	0.9709	0.9615	0.9524	0.9434	0.9346	0.9229	0.9174	0.9091	1
2	1.9704	1.9415	1.9115	1.8661	1.8594	1.8334	1.8080	1.7833	0.7591	1.7355	2
3	2.9410	2.8839	2.8286	2.2751	2.7232	2.7232	2.6730	2.5711	2.5313	2.4868	3
4	3.9020	3.8067	3.7171	3.6299	3.5459	4.4651	3.3872	3.3121	3.2397	3.1699	4
5	4.8535	4.7134	4.5797	4.4518	4.3294	4.2123	4.1002	3.9927	3.8896	3.7908	5
6	5.7955	5.6014	5.4172	5.2421	3.0757	4.9173	4.7665	4.6229	4.4859	4.3553	6
7	6.7282	6.4720	6.2302	6.0020	5.7863	5.5825	5.3893	5.2064	5.0329	4.8664	7
8	7.6517	7.3254	7.0195	6.7327	6.4632	6.2098	5.9713	5.7466	5.5348	5.3249	8
9	8.5661	8.1622	7.7861	7.4353	7.078	6.8017	6.5152	6.2462	5.8552	5.7590	9
10	9.4714	8.9825	8.5402	8.1109	7.7217	7.3601	7.0236	6.7101	6.4176	6.1446	10
11	10.3677	9.7868	9.2926	8.7601	8.3064	7.8868	7.4987	7.1389	6.8052	6.4951	11
12	11.2552	10.5773	9.9539	9.3840	8.8332	8.3838	7.9427	7.5361	7.1607	6.8137	12
13	12.1338	11.3483	10.6349	9.9896	9.3945	9.8527	8.3576	7.9038	7.7861	7.1034	13
14	13.0038	12.1062	11.2960	10.5631	9.9936	8.2950	8.7454	8.2442	7.3667	7.3667	14
15	13.8651	12.8492	11.9379	11.1183	10.3796	9.7122	9.1079	9.5595	8.0607	7.6061	15
16	14.7180	13.5777	12.5610	11.6322	10.8377	10.1059	9.4446	8.8814	8.3425	7.8227	16
17	15.5624	14.2910	13.1660	12.1656	11.3740	10.1772	9.4632	9.1315	8.5136	8.0215	17
18	16.3984	14.9933	13.7644	12.6592	11.6395	10.8276	10.0591	9.3719	8.7556	8.2014	18
19	17.2261	15.6784	14.3217	13.1339	12.0963	11.1581	10.3356	9.6036	8.9501	8.3649	19
20	18.0467	16.3514	14.8774	13.5903	12.4632	11.4699	10.5940	9.8181	9.1285	8.5136	20
21	18.8671	17.0111	15.1149	14.0791	12.8121	11.7740	10.8355	10.0168	9.2922	8.6487	21
22	19.6605	17.6580	15.9368	14.4544	13.1630	12.0416	11.0612	10.2007	9.4424	8.7715	22
23	20.4559	18.2921	16.4435	14.8568	13.4885	12.3033	11.2722	10.3710	9.5802	8.8832	23
24	21.2435	18.9139	16.9355	15.2469	13.7986	12.5503	11.4693	10.5287	9.7066	8.9847	24
25	22.0233	19.5234	17.4131	15.6220	14.0939	12.7883	11.6533	10.6748	9.8226	8.0770	25

PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE ANNUALLY

at the end of each period

Year	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	Year
1	0.9009	0.8929	0.8850	0.8772	0.8696	0.8621	0.8547	0.847	0.8403	0.8333	1
2	1.7120	1.6901	1.6681	1.6467	1.6257	1.6052	1.5852	1.5656	1.5655	1.5465	2
3	2.4437	2.4018	2.3612	2.3216	2.2832	2.2459	2.2096	2.1743	2.1399	1.1065	3
4	3.1024	3.0373	3.9745	2.9137	2.8556	2.2982	2.7462	2.6901	2.6386	2.5887	4
5	3.6959	3.6048	3.5172	3.4331	3.3522	3.2743	3.1993	3.1272	3.0576	3.9906	5
6	4.2305	4.1114	0.9976	3.8887	3.6847	3.6847	3.5892	3.4976	3.4088	3.3255	6
7	4.7122	4.5638	4.4226	4.2883	4.1604	4.0387	3.9224	3.8115	3.7057	3.6075	7
8	5.1461	4.9676	4.7988	4.6389	4.4873	4.3436	4.2024	4.0776	3.9554	3.8372	8
9	5.5370	5.3282	5.1317	4.9464	4.7716	5.6065	4.4506	4.3030	4.1633	4.0310	9
10	5.8892	5.6502	5.4262	5.2161	5.0188	4.8362	4.6586	4.4941	4.3389	4.1925	10
11	6.2065	5.9307	5.6869	5.4527	5.2337	5.0286	5.7364	4.6560	4.4865	4.3271	11
12	6.4924	6.1944	5.9176	5.6603	5.4206	5.1971	4.9184	4.7932	4.6105	4.4392	12
13	6.7499	6.4235	6.1218	5.8424	5.5831	5.3423	5.1184	4.9094	4.7147	4.5327	13
14	6.9819	6.6282	6.3025	6.0021	5.7245	5.4675	5.2293	5.0088	4.8023	4.6106	14
15	7.1909	6.8109	5.4624	6.4122	5.8474	5.5755	5.3242	5.0916	4.8759	4.6755	15
16	7.3792	6.9740	6.6039	6.2651	5.9542	5.6686	5.4053	5.1624	4.9377	4.7296	16
17	7.5488	7.1196	7.7291	6.3729	6.0472	5.7487	5.4746	3.2223	4.9897	4.7746	17
18	7.7016	7.2497	6.8099	6.4674	6.1280	5.8178	5.5339	5.2032	5.0333	4.8122	18
19	7.8393	7.3658	6.9380	6.5504	6.1982	5.8765	5.5845	5.3162	5.0700	4.8435	19
20	7.9633	7.4694	6.0248	6.6231	6.2593	5.9288	5.6278	5.3527	5.1009	4.8696	20
21	8.0751	7.5620	7.1016	6.6870	6.3125	5.9731	5.6648	5.3867	5.1268	4.8912	21
22	8.1757	7.6446	7.1695	6.4729	6.3587	6.0113	5.6964	5.4099	5.1486	4.9094	22
23	8.2664	7.7184	7.2297	6.7228	6.3981	6.0442	5.7234	5.4321	5.1668	4.9425	23
24	8.3481	7.7843	7.2829	6.8351	6.4338	6.0726	5.7465	5.4509	5.1822	4.9371	24
25	8.4217	7.8431	7.3300	6.8729	6.4641	6.0971	5.7662	5.4696	5.1951	4.9476	25

PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE ANNUALLY
at the end of each period

Year	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	Year
1	0.8264	0.8197	0.8130	0.8065	0.8000	0.7937	0.7824	0.7813	0.7752	0.7692	1
2	1.5095	1.4915	1.4740	1.4568	1.4000	1.4235	1.4074	1.3916	1.3761	1.3600	2
3	2.0793	2.0422	2.0114	2.9813	2.9520	1.9234	1.8956	1.8684	1.8420	1.8161	3
4	2.5404	2.4936	2.4483	2.4043	2.3616	2.3202	2.2800	2.2410	2.2031	2.1662	4
5	2.9260	2.8636	2.8085	2.7454	2.6893	2.6351	2.5827	2.5320	2.4830	2.4356	5
6	3.2446	3.9169	3.0923	3.0205	2.9514	2.8850	2.8210	2.7594	2.7000	2.6427	6
7	3.5079	3.4155	3.3272	3.2420	3.1611	3.0833	3.0087	2.9370	2.8662	2.8021	7
8	3.7256	3.6193	3.5179	3.4212	3.3289	3.2407	3.1564	3.0758	2.9986	2.9247	8
9	3.9054	3.7863	3.6731	3.4655	3.4631	3.3657	3.2728	3.1842	3.0997	3.0190	9
10	4.0541	3.9232	3.7993	3.6819	3.5705	3.4648	3.3644	3.2689	3.1781	3.0915	10
11	4.1769	4.0354	3.9018	3.7757	3.6564	3.5435	3.4365	3.3351	3.2388	3.1473	11
12	4.2785	4.1274	3.9853	0.8514	3.7251	3.6060	3.4933	3.3878	3.2859	3.1903	12
13	4.3624	4.2028	4.0530	3.9124	3.7801	3.6555	3.6381	3.4272	3.3224	3.2233	13
14	4.4317	4.2646	4.1082	3.9616	3.8241	3.6949	3.5733	3.4587	3.3507	3.2487	14
15	4.4890	4.3152	4.1530	4.0013	3.8593	3.7261	3.6010	3.4834	3.3726	3.2682	15
16	4.5364	4.3567	4.1894	4.0303	3.8874	3.7509	3.6228	3.5026	3.3890	3.2832	16
17	4.5755	4.3908	4.2190	4.0521	3.9099	3.7705	3.6400	3.5177	3.4028	3.2948	17
18	4.6079	4.4187	4.2431	4.0799	3.9279	3.7861	3.6536	3.5292	3.4130	3.0737	18
19	4.6346	4.4415	4.2627	4.0967	3.9424	3.7985	3.6642	3.5386	3.4210	3.3105	19
20	4.6567	4.4608	4.2786	4.1103	3.9539	3.8083	3.6726	3.5458	3.4271	3.3158	20
21	4.6752	4.4756	4.2916	4.1212	3.9631	3.8161	3.6792	3.5514	3.4319	3.3198	21
22	4.6900	4.4882	4.3021	4.1300	3.9705	3.8223	3.6844	3.5558	3.4356	3.3230	22
23	4.7025	4.4985	4.3106	4.1371	3.9764	3.8273	3.6885	3.5502	3.4384	3.3524	23
24	4.7128	4.5070	4.3176	4.1428	3.9811	3.1313	3.6918	3.5629	3.4406	3.3272	24
25	4.7213	4.5139	4.3232	4.1474	3.9849	3.8342	3.6943	3.5640	3.4423	3.3286	25

method, on the other hand, discounts expected cash flows at a required rate of return commonly known as the cut off rate and advocates the acceptance of the project if the discounted cash inflows are more than the discounted cash outflows.

For making a choice between two projects competing for the funds at the disposal of a concern, the net present value method can give a better choice because it can give better idea of ranking of the projects. The basic presumption behind discounting cash flow methods is that cash inflows must be reinvested to yield the discounting rate. It is easy to make reinvestment of funds at the cut off rate than at the internal rate of return which is usually higher than the cut off rate. Hence, the net present value method being based at a cut off rate is more reliable in ranking two or more projects than the internal rate of return method.

ILLUSTRATION 9. A company has just purchased a new plant for Rs. 60,000. The effective life of the plant is three years and has no salvage value. The estimated cash flows after tax (CFAT) are as follows:

Year	CFAT
	Rs.
1	30,000
2	30,000
3	30,000

Compute the following :

- (1) Payback period
- (2) Net present value at 15% rate of discount.

Note. The present value of Re. 1 at 15% discount rate is :

Year 1	0.870
Year 2	0.756
Year 3	0.658

SOLUTION

$$(1) \text{ Calculation of Payback Period} = \frac{\text{Cost of the plant}}{\text{Cash flows after tax per year}} = \frac{\text{Rs. } 60,000}{\text{Rs. } 30,000} = 2 \text{ years}$$

(2) Calculation of Net Present Value

Year	CFAT	Discount factor at 15%	Present value of cash flows
	Rs.		Rs.
1	30,000	0.870	26,100 (i.e., 30,000 × 0.870)
2	30,000	0.756	22,680 (i.e., 30,000 × 0.756)
3	30,000	0.658	19,740 (i.e., 30,000 × 0.658)
<i>Less: Cost of plant</i>			68,520
<i>Net present value</i>			60,000
			<u>8.520</u>

Note. Depreciation has not been added because cash flows after tax must have been calculated after adding back depreciation.

ILLUSTRATION 10. A Ltd. is considering the question of taking up a new project which requires an investment of Rs. 200 lakhs on machinery and other assets. The project is expected to yield the following gross profits (before depreciation and tax) over the next five years :

Year	Gross Profit (in lakhs of Rs.)
1	80
2	80
3	90
4	90
5	75

(Continued on page II/14.23)

PRESENT VALUE TABLE
PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE
at the end of each period

Year	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	Year
01	0.99010	0.98039	0.97007	0.96154	0.95238	0.94340	0.93458	0.92593	0.91743	0.90909	01
02	.98030	.96117	.94260	.92456	.90703	.89000	.87344	.85734	.84168	.82645	02
03	.97059	.94232	.91514	.88900	.86384	.83962	.81630	.79383	.77288	.75131	03
04	.96098	.92385	.88849	.85480	.82270	.79209	.76290	.73503	.70843	.68301	04
05	.95147	.90573	.86261	.82193	.78353	.74726	.71299	.68058	.64993	.62092	05
06	.94204	.88797	.83748	.79031	.74622	.70496	.66634	.63017	.59627	.56447	06
07	.93272	.87056	.81309	.74992	.71068	.66506	.62275	.58349	.54703	.51361	07
08	.02348	.85249	.78941	.73069	.67684	.62741	.58201	.54027	.50187	.46651	08
09	.91434	.83675	.76642	.70259	.64461	.59190	.54393	.50025	.46043	.42410	09
10	.90529	.82036	.74409	.67556	.61391	.55839	.50835	.46319	.42241	.38554	10
11	.89632	.80426	.72242	.64958	.58468	.52679	.47509	.42888	.38653	.35042	11
12	.88746	.78849	.70138	.62460	.55684	.49597	.44401	.30711	.35553	.31866	12
13	.87866	.77303	.68095	.60057	.53012	.46884	.41496	.36770	.32618	.28965	13
14	.86996	.75787	.66112	.57747	.50507	.44230	.38782	.34046	.29925	.26333	14
15	.86135	.74301	.64186	.55526	.48102	.41726	.36245	.31524	.27454	.23939	15
16	.85282	.72845	.62317	.53391	.45811	.39365	.33873	.29189	.25187	.21763	16
17	.84438	.71416	.60502	.51337	.46630	.37136	.31657	.27027	.23107	.19784	17
18	.83602	.70016	.58739	.39363	.41552	.35034	.29586	.25052	.21199	.17986	18
19	.82774	.68643	.57029	.47464	.39573	.33051	.27651	.23171	.19449	.16351	19
20	.81954	.56297	.55367	.45639	.37689	.31180	.25842	.21855	.17843	.14864	20
21	.81143	.65978	.53755	.43883	.35894	.29415	.24151	.19866	.16370	.13513	21
22	.80340	.64684	.52189	.42195	.34185	.27750	.22571	.18394	.15018	.12285	22
23	.79544	.63416	.50669	.40573	.32557	.26180	.21095	.17031	.13778	.11168	23
24	.78757	.62172	.49193	.39012	.31007	.24698	.19715	.15770	.12640	.10153	24
25	.77977	.60953	.47760	.37512	.29530	.23300	.18425	.14602	.11597	.09230	25

PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE
at the end of each period

Year	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	Year
01	0.90090	0.89286	0.88496	0.87719	0.86957	0.86207	0.85470	0.84746	0.84034	0.83333	01
02	.81162	.79719	.78315	.76947	.75614	.74316	.73051	.71818	.70616	.69444	02
03	.73119	.71178	.60305	.67497	.65752	.64066	.62437	.60863	.59342	.57870	03
04	.65873	.63552	.61332	.59208	.57175	.55229	.53365	.51570	.49867	.48225	04
05	.50345	.56743	.54276	.51937	.49718	.47611	.45611	.43711	.41905	.40188	05
06	.59367	.50663	.48032	.45559	.4223	.41044	.38984	.37043	.35214	.33490	06
07	.48166	.45305	.42506	.39964	.37594	.35383	.33320	.31392	.29592	.27908	07
08	.43493	.45388	.37616	.35056	.32690	.30505	.28478	.26604	.24867	.23257	08
09	.39092	.36061	.33288	.30751	.28426	.26226	.24340	.22546	.20897	.19381	09
10	.35218	.32197	.29459	.26974	.24718	.22668	.20804	.19106	.17560	.16151	10
11	.31728	.28748	.26070	.233362	.21494	.19542	.17781	.16192	.14576	.13459	11
12	.28583	.25667	.23071	.20756	.16691	.16846	.15197	.13722	.12400	.11216	12
13	.25751	.22917	.20416	.18237	.18253	.14523	.12989	.11629	.10420	.09356	13
14	.23199	.20462	.18068	.15971	.14133	.12520	.11102	.09855	.08757	.07789	14
15	.20900	.18270	.15988	.14010	.12289	.10793	.09489	.08352	.07359	.06491	15
16	.18829	.16312	.14150	.12289	.10686	.09304	.08110	.07078	.06184	.05409	16
17	.14963	.17564	.12522	.10780	.09292	.08021	.06932	.05998	.05196	.04507	17
18	.15282	.13004	.11081	.09456	.08080	.06914	.05924	.05083	.04367	.03756	18
19	.13768	.11611	.09806	.08285	.07026	.05961	.05064	.04303	.03669	.03130	19
20	.12403	.10367	.08678	.07275	.06110	.05139	.04328	.03081	.02608	.02608	20
21	.11174	.09256	.07680	.06383	.05313	.04430	.03699	.03094	.02591	.02174	21
22	.10067	.08264	.06796	.05599	.04620	.03819	.03162	.02622	.02178	.01811	22
23	.09069	.07379	.06014	.04911	.04017	.03292	.02702	.02222	.01830	.01509	23
24	.08170	.06588	.05322	.04306	.03493	.02838	.02310	.01883	.01538	.01258	24
25	.07361	.05882	.04710	.03779	.03038	.02447	.01974	.01595	.01292	.01048	25

PRESENT VALUE OF Re. 1 PAYABLE OR RECEIVABLE

at the end of each period

Year	21%	22%	23%	24%	25%	26%	27%	28%	29%	30%	Year
01	0.82645	0.81967	0.81301	0.80645	0.80000	0.79365	0.78740	0.78126	0.77519	0.76923	01
02	.68301	.67186	.66098	.65036	.64000	.62988	.62000	.61035	.60093	.59172	02
03	.56447	.55071	.53738	.52449	.51200	.49991	.48810	.47684	.46583	.45517	03
04	.46651	.45140	.43690	.42297	.40960	.38440	.37253	.36111	.35013	.3404	04
05	.38554	.37000	.35520	.34111	.32768	.31488	.30268	.29104	.27993	.26933	05
06	.31863	.30328	.28878	.27509	.26214	.24991	.23833	.22737	.21700	.20718	06
07	.26333	.24859	.23478	.22184	.20972	.19834	.18766	.17764	.16822	.15897	07
08	.21763	.20376	.19088	.17891	.16777	.15741	.14776	.13878	.13040	.12259	08
09	.17986	.16702	.15519	.14428	.13422	.12493	.11636	.10842	.10109	.09403	09
10	.14864	.13690	.12617	.11635	.10737	.09915	.09161	.08470	.07836	.07254	10
11	.12285	.11221	.10258	.09383	.08590	.07869	.07214	.06617	.06075	.05580	11
12	.10153	.09198	.08339	.07567	.06872	.06245	.05680	.05170	.04709	.04292	12
13	.08391	.07539	.06780	.06103	.05498	.04594	.04472	.04039	.03650	.03302	13
14	.06934	.06190	.05512	.04921	.04398	.03934	.03522	.03255	.02830	.02540	14
15	.05731	.08065	.04481	.03969	.03518	.03122	.02773	.02465	.02194	.01954	15
16	.04736	.04152	.03643	.03201	.02815	.02478	.02183	.01926	.01700	.01503	16
17	.03914	.03403	.02962	.02581	.02252	.01967	.01719	.01505	.01318	.01156	17
18	.03235	.02789	.02408	.02082	.01801	.01561	.01354	.01175	.01022	.00889	18
19	.02673	.02286	.01958	.01679	.01441	.01239	.01066	.00918	.00792	.00684	19
20	.02209	.01874	.01522	.01354	.01153	.00983	.00839	.00717	.00614	.00526	20
21	.01826	.01536	.01249	.01092	.00922	.00780	.00661	.00561	.00476	.00405	21
22	.01509	.01259	.01052	.00880	.00738	.00619	.00520	.00438	.00369	.00311	22
23	.01247	.01032	.00855	.00710	.00590	.00491	.00410	.00342	.00286	.00239	23
24	.01031	.00846	.00695	.00573	.00472	.00390	.00323	.00267	.00222	.00184	24
25	.00852	.00693	.00565	.00462	.00378	.00310	.00254	.00239	.00172	.00142	25

The cost of raising the additional capital is 12% and the assets have to be depreciated at 20% on written down value basis. The scrap value at the end of 5 years period may be taken as zero. Income tax payable by the company is 50%.

Calculate the net present value of the project and advise the management whether the project has to be implemented. Also calculate the internal rate of return of the project.

Note : Present value of Re. 1 at different rates of interest are as follows :

Year	Present Value			
	10%	12%	14%	16%
1	0.91	0.89	0.88	0.86
2	0.83	0.80	0.77	0.74
3	0.75	0.71	0.67	0.64
4	0.68	0.64	0.59	0.55
5	0.62	0.57	0.52	0.48

SOLUTION

*Calculation of Cash Flows For Working Out the net Present Value and Internal Rate of Return
(In Lacs of Rs.)*

Year	Profit before Depreciation and Tax	Depreciation @ 20% on W.D.V. of Assets	Profit before Tax (PBT) (2) - (3)	Tax @ 50%	Profit after Tax (PAT) (4) - (5)	Cash Inflow (PAT + Depreciation) (6) + (3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	80	40 (20% of 200)	40	20	20	60
2	80	32 (20% of 160)	48	24	24	56
3	90	25.6 (20% of 128)	64.4	32.2	32.2	57.8
4	90	20.48 (20% of 102.4)	69.52	34.76	34.76	55.24
5	75	16.38 (20% of 81.92) 81.92 65.54 (Loss on disposal of Asset i.e., W.D.V of Assets after 5 years (200 - 40 - 32 - 25.6 - 20.48 - 16.38))	- 6.92	- 3.46	- 3.46	78.46

Calculation of Net Present Value and Internal Rate of Return

(In Lacs of Rs.)

Year	Cash	Discounted Factor 12%	Present Value at 12% D.F. (2) × (3)	Discounted Factor 14%	Present Value at 14% D.F. (2) × (5)	Discounted Factor 16%	Present Value at 16% D.F. (2) × (7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	60	0.89	53.40	0.88	52.80	0.86	51.60
2	56	0.80	44.80	0.77	43.12	0.74	41.44
3	57.80	0.71	41.04	0.67	38.73	0.64	36.99
4	55.24	0.64	35.35	0.59	32.59	0.55	30.38
5	78.46	0.57	44.72	0.52	40.80	0.48	37.66
Initial Cost of Assets			219.31		208.04		198.07
Present Value			200.00		200.00		200.00
			19.31		8.04		- 1.93

Net Present Value at 12% = Rs. 19.31 lakhs.

$$\text{Internal Rate of Return} = 14\% + \frac{\text{Rs. } 8.04 \text{ lakhs}}{\text{Rs. } 8.04 \text{ lakhs} - (-\text{Rs. } 1.98 \text{ lakhs})} \times 2\%$$

$$= 15.6\%$$

ILLUSTRATION 11. The management of a firm is considering an investment project costing Rs. 1,50,000 and it will have a scrap value of Rs. 10,000 at the end of its 5 year-life. Transportation charges are expected to be Rs. 5,000 and installation charges are expected to be Rs. 25,000. If the project is accepted, a spare part inventory of Rs. 10,000 must also be acquired and maintained. It is estimated that the spare part will have an estimated scrap value after 5 years of 60% of their initial costs.

Annual revenue from the project is expected to be Rs. 1,70,000 and annual labour, material and maintenance expenses are estimated to be Rs. 15,000, Rs. 50,000 and Rs. 5,000 respectively. The depreciation and taxes for each of the five years will be :

Year	Depreciation		Taxes	
		Rs.		Rs.
1		72,000		11,200
2		43,200		22,720
3		32,400		27,040
4		21,600		31,360
5		800		39,680

Calculate Net Cash Flows each year and cost of the project. Evaluate the project at 12% rate of interest. The discount factors at 12% are :

Year	1	2	3	4	5
Discount Factor at 12%	0.9	0.8	0.7	0.6	0.57

SOLUTION

Calculation of Earning Before Depreciation and Tax

Annual Revenue from the project		Rs.
		1,70,000
Less : Annual Expenses :		
Materials		50,000
Labour		15,000
Maintenance Expenses		5,000
		<u>70,000</u>
Earnings before depreciation and taxes		<u>1,00,000</u>

STATEMENT SHOWING COMPUTATION OF NET CASH FLOWS

Year	Earnings before Depreciation & Taxes	Depreciation	Earnings before Taxes	Taxes	Earnings after Taxes	Net Cash Flows (Earnings after Taxes plus Depreciation)
1	Rs. 1,00,000	72,000	Rs. 28,000	Rs. 11,200	Rs. 16,800	Rs. 88,800
2	1,00,000	43,200	56,800	22,720	34,080	77,280
3	1,00,000	32,400	67,600	27,040	40,560	72,960
4	1,00,000	21,600	78,400	31,360	47,040	68,640
5	1,00,000	800	99,200	39,680	59,520	60,310

STATEMENT SHOWING COST OF THE PROJECT

		Rs.
Cost of the Project		50,000
Add : Transportation charges		5,000
Installation charges		25,000
		<u>1,80,000</u>
Add : Spare parts inventory to be maintained		10,000
Total cost of the project		<u>1,90,000</u>

Salvage value at the end of the 5th year

Salvage value of the project	10,000
Salvage value of spare parts	6,000
Total	<u>16,000</u>

STATEMENT SHOWING EVALUATION OF THE PROJECT AT 12% RATE OF INTEREST

Year	Net Cash Flows	Discount Factor at 12%	Present Value at 12% (2 × 3)
0	(2) Rs. (-) 1,90,000 (Total cost of the project)	(3) Rs. 1.00	(4) I.s. (-) 1,90,000
1	88,800	0.90	79,920
2	77,280	0.80	61,824
3	72,960	0.70	51,072
4	68,640	0.60	41,184
5	76,320 (Earnings Rs. 60,320 + Salvage value Rs. 16,000)	0.57	43,502
		Net Present value	<u>87,502</u>

The project should be accepted because net present value is positive.

ILLUSTRATION 12. A machine purchased six years back for Rs. 1,50,000 has been depreciated to a book value of Rs. 90,000. It originally had a projected life of fifteen years and zero salvage value. A new machine will cost Rs. 2,50,000 and result in a reduced operating cost of Rs. 30,000 per year for the next 9 years. The older machine could be sold for Rs. 50,000. The machine also will be depreciated on a straight line method on nine-year life with salvage value of Rs. 25,000. The company's tax rate is 50% and cost of capital is 10%.

Determine whether the old machine should be replaced.

Given—Present value of Re. 1 at 10% on 9th year = 0.424 ; Present value of an annuity of Re. 1 at 10% for 8 years = 5.335.

SOLUTION

Computation of Cash Outflows

	Rs.
Cost of the new machine	Rs. 2,50,000
Less: Sale value of old machine	50,000
Tax saving from loss due to sale of old machine @ 50% of Rs. 40,000 (i.e., Rs. 90,000 Book Value – Rs. 50,000 Amount Realised on Sale of Old Machine)	<u>20,000</u>
	<u>70,000</u>
Net Cash Outflows on Installing New Machine	<u>1,80,000</u>

Computation of Cash Inflows

	Amount before Tax Rs.	Amount after 50% Tax Rs.
Cost savings per annum on installation of new machine	30,000	15,000
Tax savings on depreciation :		
Depreciation on new machine		
(<u>Rs. 2,50,000 – Rs. 25,000 Scrap Value</u>)	9	Rs. 25,000

Less: Depreciation on old machine

$\left(\frac{\text{Rs. } 1,50,000}{15} \right)$	Rs. 10,000	
		15,000
		7,500
		22,500
		25,000
		22,500
		47,500

Cash Inflows per annum for 8 years

Salvage value realised in 9th year

Add: Cash inflows per annum as calculated above

Cash inflows for 9th year

DETERMINATION OF NET PRESENT VALUE

<i>Years</i>	<i>Cash Flows after Tax</i>	<i>Present Value Factor at 10%</i>	<i>Present Value (Cash Flow \times PV Factor)</i>
	Rs.		Rs.
1-8	22,500	5.335	1,20,038
9	47,500	0.424	20,140
			1,40,178
			- 1,80,000
			- 39,822

Since the net present value is negative, the old machine should not be replaced.

ILLUSTRATION 13. A company is setting up a plant at a cost of Rs. 300 lakhs investment in fixed assets. It has to decide whether to locate the plant in a Forward area or Backward area. Locating in backward area means a cash subsidy of Rs. 15 lakhs from the Central Govt. Besides the taxable profit to the extent of 20% is exempted for 10 years. The project envisages a borrowing of Rs. 200 lakhs in either case. The cost of borrowing will be 12% in Forward area and 10% in Backward area. However, the revenue costs are bound to be higher in Backward area. The borrowings (Principal) have to be repaid in four equal annual instalments beginning from the end of the 4th year. With the help of the following information and by using DCF technique you are required to suggest the proper location for the project. Assume straight line depreciation with no residual value : -

<i>Year</i>	<i>Profit (Loss) Before Interest and Depreciation (Rs. in Lakhs)</i>		<i>Present Value Factor (at 15%)</i>
1	FA (6.00)	BA (50.00)	0.87
2	34	(20)	0.76
3	54	10	0.66
4	74	20	0.57
5	108	45	0.50
6	142	100	0.43
7	156	155	0.38
8	230	190	0.33
9	330	230	0.28
10	430	330	0.25

You are to assume :

- (a) Average rate of income-tax is to be taken at 50%.
- (b) The life of the fixed asset will be 10 years.
- (c) Central subsidy receipt is not to affect depreciation and tax.
- (d) No other reliefs or rebates other than those indicated in the question will be available to the company.

SOLUTION

(For Solution of Statement showing the Net Present Value of the Plant at 15% in Forward and Backward Area please see next two pages)

STATEMENT SHOWING THE NET PRESENT VALUE OF THE PLANT AT 15% IN FOWARD AREA

(Figures in Lakhs)

STATEMENT SHOWING THE NET PRESENT VALUE OF THE PLANT AT 15% IN BACKWARD AREA

(Figures in Lakhs)

Year	Profit (Loss) before Interest & Depre- ciation	Deprecia- tion	Interest	Profit (Loss) after Deprecia- tion & Interest	Income Tax	Profit (Loss) after Tax	Cash Inflows (i.e. Profit) after Tax + Depre- ciation	Cash Outflows (Invest- ment Loss and Loan Repayment)	Net Cash Inflow (Outflow)	Present Value Factor at 15%	Discounted Value of Cash Inflows (Outflows)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
0	—	—	—	—	—	—	—	—	85	1.00	(85)
1	(50)	30	20	(100)	—	(100)	(70)	—	—	0.87	(60.9)
2	(20)	30	20	(70)	—	(70)	(40)	—	—	0.76	(30.4)
3	10	30	20	(40)	—	(40)	(10)	—	—	0.66	(6.6)
4	20	30	20	(30)	—	(30)	—	—	50	0.57	(28.5)
5	45	30	15	—	—	—	30	50	50	0.50	(10.0)
6	100	30	10	60	—	60	90	50	40	0.43	17.2
7	155	30	5	120	—	120	150	50	100	0.38	38.0
8	190	30	—	160	40	120	150	—	150	0.33	49.5
9	230	30	—	200	80	120	150	—	150	0.28	42.0
10	330	30	—	300	120	180	210	—	210	0.25	52.5
											Net Present Value (22.2)

Conclusion. The net present value of the plant in the Forward area is Rs. 100.2 lakhs whereas the net present value of the plant in the Backward area is Rs. 22.2 lakhs negative. Therefore, proper location of the plant is the Forward area.

Working Notes :

	In Rs. Lakhs
(1) Cost of the Plant	100
Less : Borrowing	—
Investment from within Forward area	<u>100</u>

Investment from within Backward area (Rs. 100 lakhs—Rs. 15 lakhs cash subsidy) 85

(2) Income tax liability has been calculated after adjusting previous years losses. Previous years losses can be carried forward to be adjusted in future years profits. In backward area, 20% profits after adjusting previous years' losses have not been taxed.

(3) In Forward area, interest on loan has been calculated @ 12% (as given) and in backward area, it has been calculated @ 10%.

ILLUSTRATION 14. The M N Company limited has decided to increase its productive capacity to meet an anticipated increase in demand for its products. The extent of this increase in capacity is still to be determined and a management meeting has been called to decide which of the following two mutually exclusive proposals I and II should be undertaken. On the basis of the information given below you are required to : -

- (i) evaluate the profitability (ignoring taxation) of each of the proposals and
- (ii) On the assumption of a cost of capital of 8% advise the management of the matter to be taken into consideration when deciding between Proposal I and Proposal II.

Capital Expenditure	<i>I</i>	<i>II</i>
	Rs.	Rs.
Building	50,000	1,00,000
Plant	2,00,000	3,00,000
Installation	10,000	15,000
Working Capital	50,000	65,000
Net Income :		
Annual pre-depreciation profits (Note a)	70,000	95,000
Other relevant income/expenditure :		
Sales Promotion (Note b)	—	15,000
Plant Scrap Value	10,000	15,000
Building Disposable Value (Note c)	30,000	60,000

Notes :

(a) The investment life is 10 years.

(b) An exceptional amount of expenditure on sales promotion of Rs. 15,000 will require to be spent in year 2 on proposal II. This has not been taken into account in calculating pre-depreciation profits.

(c) It is not the intention to dispose of the building in ten years' time, however, it is company policy to take notional figure into account for project evaluation purposes.

The present value of Re. 1 due	1 year hence at 8%	= 0.926
	2	= 0.857
	3	= 0.794
	4	= 0.735
	5	= 0.681
	6	= 0.630
	7	= 0.583
	8	= 0.540
	9	= 0.500
	10	= 0.463
	11	= 0.429

SOLUTION

(i) Evaluation of the Profitability of Each Proposal

	Proposal I Rs.	Proposal II Rs.
Original Investment :		
Building	50,000	1,00,000
Plant	2,00,000	3,00,000
Installation	10,000	15,000
Working Capital	50,000	65,000
	<u>3,10,000</u>	<u>4,80,000</u>
Average Earnings per annum (2)	48,000	59,500
Rate of Return :	$\frac{48,000}{3,10,000} \times 100$	$\frac{59,500}{4,80,000} \times 100$
	$= 15.5\%$	$= 12.4\%$

Working Notes :

(1) Calculation of Depreciation (assuming straight line method)

Building
Less : Disposable value after 10 years

Depreciation per annum

Plant including Installation
Less : Scrap value after 10 years

Depreciation per annum

Total Depreciation on Building & Plant

(2) Calculation of Average Earnings

Annual Profits before Depreciation
Less : Depreciation

Earnings before Sales Promotion Expenses

Annual Average Profits :

	Proposal I Rs.	Proposal II Rs.
50,000	1,00,000	
30,000	60,000	
<u>20,000</u>	<u>40,000</u>	
2,000	4,000	
(20,000 \div 10)	(40,000 \div 10)	
2,10,000	3,15,000	
10,000	15,000	
<u>2,00,000</u>	<u>3,00,000</u>	
20,000	30,000	
(2,00,000 \div 10)	(3,00,000 \div 10)	
22,000	34,000	
(2,000 + 20,000)	(4,000 + 30,000)	
70,000	95,000	
22,000	34,000	
<u>48,000</u>	<u>61,000</u>	
$\frac{48,000}{10} \times 10$	$(61,000 \times 10)$	
	- 15,000 Sale Promotion Expense in year 2	
	10	
	$= 48,000$	$= 59,500$

(ii) Calculation of Net Present Value of Proposals I and II

Year	P.V.Factor at 8%	Proposal I		Proposal II	
		Profits before Depreciation	Present Value of Profits	Profits before Depreciation	Present Value of Profits
(1)	(2)	(3)	(4)	(5)	(6)
		Rs.	Rs.	Rs.	Rs.
1	0.926	70,000	64,820	95,000	87,950
2	0.857	70,000	59,990	80,000	68,560
3	0.794	70,000	55,580	95,000	75,430
4	0.735	70,000	51,450	95,000	69,525
5	0.681	70,000	47,670	95,000	64,595

6	0.630	70,000	44.100	95,000	59,850
7	0.583	70,000	40,810	95,000	55,385
8	0.540	70,000	37,800	95,000	51,300
9	0.500	70,000	35,000	95,000	47,500
10	0.463	70,000	32,410	95,000	43,985
10	0.463	(1) 90,000	41,670	(1) 1,40,000	64,820
			5,11,300		6,89,320
Less : Initial Investment			3,10,000		4,80,000
Net Present Value			2,01,300		2,09,320

(1) Scrap value of plant plus disposable value of building plus release of working capital.

Proposal II should be undertaken as the net present value of proposal II exceeds the net present value of proposal I. However, the following matters should also be taken into consideration when deciding between proposal I and proposal II :-

1. Initial Cash Outflow. Initial outflow of cash on proposal I and proposal II is different. Therefore, two proposals are not comparable. If proposal I is accepted and the difference of funds between proposal II and proposal I is gainfully employed in proposal III. If the net present value of proposals I and III exceeds the net present value of proposal II, it will be better to accept proposal I alongwith proposal III. Thus, the cost of acquiring the fixed assets, the cash position and the availability of cash either from within or by borrowing should be considered before making a choice of suitable project.

2. Degree of Risks Involved. If proposal I and proposal II have different degree of risk, the same discounting rate should not be used. A proposal bearing a higher degree of risk should have a higher rate of discount for its cash flows.

3. Discounting Rate. A discounting rate of 8% is too low for the purpose of evaluation of the two proposals. A suitable discounting rate keeping in view the cost of capital should be adopted for the evaluation of the two proposals.

4. The Amount and Timing of Cash Inflows and Outflows. The shorter is the period within which the cost of the project is recovered, the less risky is the project and the greater is its liquidity. Proposal I is better than proposal II in this respect because proposal I recovers its initial investment in 6 years approximately whereas proposal II recovers its initial investment in about 7 years keeping in view the present value of cash inflows.

ILLUSTRATION 15. A company is considering modernisation of its process of manufacture by either upgrading its existing machinery or purchasing a latest model of new machine. Its existing machine is operational and can be operated for another five years. The present machinery was purchased five years back for Rs. 75,000 and has been fully depreciated during this period. It has a realisable value of Rs. 30,000. The cost of upgradation has been worked out at Rs. 2 lakhs while the new machine will cost Rs. 3.50 lakhs including installation charges.

The projected profit after tax under the three operations for the next five years and the estimated salvage value at the end of this period are given below :

Year	Existing machine	Upgraded machine (In lakhs of rupees)	New machine
1	1.80	2.40	2.60
2	2.00	2.80	2.90
3	2.40	3.30	3.50
4	2.80	4.10	4.50
5	3.30	4.40	4.80
Salvage value	Nil	0.40	0.60

The company uses straight line method of depreciation and this is accepted by the tax authority. The company's tax rate is 40% and its cost of capital is 12%. Advise whether the company should buy the new machine or upgrade the existing one.

Note : P.V. factor at 12% : Year 1 : 0.893, Year 2 : 0.797, Year 3 : 0.712, Year 4 : 0.636, Year 5 : 0.567.

(I.C.W.A. Inter, Dec. 2002)

CALCULATION OF NET PRESENT VALUE OF EXISTING MACHINE, UPGRADED MACHINE AND NEW MACHINE

(In Rs. lakhs)

Year	Existing Machine				Upgraded Machine				New Machine		
	P.V. Factor (2)	Cash Inflow (3)	Present Value (4)	PAT (5)	Deprn. (6)	Cash Inflow (7)	Present Value (8)	PAT (9)	Deprn. (10)	Cash Inflow (11)	Present Value (12)
1	0.893	1.80	1.61	2.40	0.40	2.80	2.50	2.60	0.70	3.30	(2) × (11) 2.95
2	0.797	2.00	1.59	2.80	0.40	3.20	2.55	2.90	0.70	3.60	2.87
3	0.712	2.40	1.71	3.30	0.40	3.70	2.63	3.50	0.70	4.20	2.99
4	0.636	2.80	1.78	4.10	0.40	4.50	2.86	4.50	0.70	5.20	3.31
5	0.567	3.30	1.87	4.40	0.40	4.80	2.72	4.80	0.70	5.50	3.12
Salvage	0.567			0.40	—	0.40	0.23	0.60	—	0.60	0.34
Total Inflow		8.56					13.49				15.58
Less : Cash Outflow at the beginning		—					2.00				3.32
Net Present Value		8.56					11.49				12.26

Since net present value of Rs. 12.6 lakhs is highest for the new machine, it may be purchased.

Cash outflow at the beginning of first year if machinery is upgraded =	Rs. 2,00,000
Cash outflow if new machinery is purchased :	Rs.
Cost of New Machine	3,50,000
Less : Amount to be realised on salvage of Old Machine	30,000
Less : Income Tax @ 40%	<u>12,000</u>
	18,000
	3,32,000

6. Profitability Index or Benefit Cost Ratio

The profitability index, also known as benefit-cost ratio, of a capital expenditure is the present value of expected net cash flows over the initial cost. It can be expressed as follows :

$$\text{Profitability Index} = \frac{\text{Present Value of Future Net Cash Flows}}{\text{Initial Cash Outlay}}$$

In Illustration 9, the profitability index is :

$$\frac{\text{Rs. } 68,520}{\text{Rs. } 60,000} = 1.14$$

If the profitability index is equal to or greater than 1, the investment proposal should be accepted. A project giving a profitability index greater than one must also offer a net present value which is positive. For any project having no alternative projects, the net present value method and the profitability index give the same accept-reject signals. But if we are to choose between mutually exclusive projects, the net present value method should be preferred because it gives us in absolute terms the expected contribution of the project. In such a case, the profitability index is not recommended because it expresses only the relative profitability. For example, consider the following mutually exclusive two projects :

	<i>Project A</i>	<i>Project B</i>
	Rs.	Rs.
Present value of net cash flows	50,000	20,000
Less : Initial cash outlay	<u>37,500</u>	<u>12,000</u>
Net Present Value	<u>12,500</u>	<u>8,000</u>
Profitability Index	$\frac{50,000}{37,500} = 1.33$	$\frac{20,000}{12,000} = 1.67$

According to the net-present-value method, project A would be recommended, whereas according to profitability index method, project B would be recommended. But project A should be preferred because it gives us the higher economic contribution of Rs. 12,500 as compared to Rs. 8,000 contribution of project B. Thus, the net present value method is the better of the two methods when we are to make a choice between mutually exclusive projects that involve different initial cash outlays.

ILLUSTRATION 16. A firm whose cost of capital is 10% is considering two mutually exclusive projects X and Y, the details of which are :

	<i>Project X</i>	<i>Project Y</i>
	Rs.	Rs.
Investment	70,000	70,000
Cash flow year 1	10,000	50,000
Cash flow year 2	20,000	40,000
Cash flow year 3	30,000	20,000
Cash flow year 4	45,000	10,000
Cash flow year 5	60,000	10,000
	<u>1,65,000</u>	<u>1,30,000</u>

Compute the net present value at 10%, profitability index and internal rate of return for the two projects.

Year	Discount Factors						
	10%	15%	20%	25%	30%	35%	40%
1	.909	.870	.833	.800	.769	.741	.714
2	.826	.756	.694	.640	.592	.549	.510
3	.751	.658	.579	.512	.455	.406	.364
4	.683	.572	.482	.410	.350	.301	.260
5	.621	.497	.402	.328	.269	.223	.186

SOLUTION

(i) Calculation of Net Present Value

(Cost of capital being 10%)

Year	Cash Inflows Project X	Cash Inflows Project Y	P.V. Factors at 10%	Discounted Cash Inflows	
				Project X	Project Y
	Rs.	Rs.		Rs.	Rs.
1	10,000	50,000	.909	9,090	45,450
2	20,000	40,000	.826	16,520	33,040
3	30,000	20,000	.751	22,530	15,020
4	45,000	10,000	.683	30,735	6,830
5	60,000	10,000	.621	37,260	6,210
Present value of cash inflows				116,135	1,06,550
Less : Initial cash outflow (investment)				70,000	70,000
Net present value				46,135	36,550

(ii) Calculation of Profitability Index

$$\text{Profitability Index} = \frac{\text{Discounted Cash Inflows}}{\text{Discounted Cash Outflows}}$$

$$\text{Project X : } \frac{\text{Rs. } 116,135}{\text{Rs. } 70,000} = 1.659$$

$$\text{Project Y : } \frac{\text{Rs. } 1,06,550}{\text{Rs. } 70,000} = 1.522$$

(iii) Internal Rate of Return for the two Projects

Project X

Year	Cash	P.V. Factor at 25%	Discounted Cash Inflows	P.V. Factor at 30%	Discounted Cash Inflows
	Rs.	Re.	Rs.	Re.	Rs.
1	10,000	.800	8,000	.769	7,690
2	20,000	.640	12,800	.592	11,840
3	30,000	.512	15,360	.455	13,650
4	45,000	.410	18,450	.350	15,750
5	60,000	.328	19,680	.269	16,140
			74,290		65,070

Present value @ 30% is Rs. 65,070. Cost of Project X is Rs. 70,000, so net present value @ 30% is negative. Hence internal rate of return must be lower than 30%. But it is higher than 25% because at that rate of discount, net present value of Rs. 74,290 is more than the cost of project. The exact internal rate of return is :

$$25\% + \frac{\text{Rs. } 74,290 - \text{Rs. } 70,000}{\text{Rs. } 74,290 - \text{Rs. } 65,070} \times 5\% = 27.33\%$$