3

CVP Analysis and Decision making

LEARNING OBJECTIVES :

After studying this unit you will be able to :

- Understand meaning and theory of Marginal Costing.
- Explain difference between Marginal Costing and Absorption Costing.
- Understand method of computing breakeven point in terms of units and sale value.
- Understand meaning of margin of safety and its computation.
- Calculate and interpret contribution to sales ratio.
- Understand method of drawing a conventional breakeven chart
- Understand advantages of a contribution breakeven chart and how to draw and use it.
- Understand advantages of a profit volume chart and the method of drawing and using it.
- Understand limitations of breakeven analysis.
- Calculate breakeven points for multipurpose situations

3.1 INTRODUCTION

According to CIMA, Marginal costing is the sysem in which variable costs are charged to cost units and fixed costs of the period are written off in full against the aggregate contribution.

Marginal costing is not a distinct method of costing like job costing, process costing, operating costing, etc. but a special technique used for marginal decision making. Marginal costing is used to provide a basis for the interpretation of cost data to measure the profitability of different products, processes and cost centre in the course of decision making. It can, therefore, be used in conjunction with the different methods of costing such as job costing, process costing, etc., or even with other technique such as standard costing or budgetary control.

In marginal costing, cost ascertainment in made on the basis of the nature of cost. It gives consideration to behaviour of costs. In other words, the technique has developed from a particular concept and expression of the nature and behaviour of costs and their effect upon the profitability of an undertaking.

Cost-volume-profit analysis (as the name suggests) is the analysis of three variable viz., cost, volume and profit. Such an analysis explores the relationship existing amongst costs, revenue, activity levels and the resulting profit. It aims at measuring variations of cost with volume. In the profit planning of a business, cost-volume-profit (C-V-P) relationship is the most significant factor.

The CVP analysis is an extension of marginal costing. It makes use of principles of marginal costing. It is an important tool of planning. It is quite useful in making short run decisions.

For this purpose we apply the concept of Marginal Costing. Following definitions are required for this purpose

1. Profit Statement Under Marginal Costing

Statement of Profit		Rs.	Rs.
Revenue/Sales			xxx
Less :	Variable cost of production		
	Material	xx	
	Labour	xx	
	D. Expenses	xx	
	Variable overhead	xx	
		xx	
Add :	Opening Finished goods (at MC)	xx	
Less :	Closing Finished goods (at MC)	xx	
Variable cost of goods sold		xxx	
Add: Variable Selling overhead		xx	
Variable cost of sales			xx
Contribution			xx
Less : All types of Fixed cost			xx
(Committed, Discretionary steps)			xx

2. Sales - Variable Cost = Contribution = Fixed Cost + Profit

3. P/V ratio (or C/S ratio) = Contribution ÷ Sales
   = Contribution per unit ÷ Selling price per unit
   = Change in Contribution ÷ Change in Sales

4. Break-even Point : Point where there is no profit or no loss.

   i) at BEP, Contribution = Fixed Cost

   Thus, Break Even Sales (in sales value) = Fixed Cost ÷ P/V ratio

5. Margin of safety = Sales – BEP sales

   = Contribution / P/V ratio - Fixed cost / P/V ratio

   = Profit / P/V ratio

6. Profit = (Sales × P/V ratio) – Fixed Cost

   = (Margin of Safety Sales) × P/V ratio

7. BEP Calculation in different scenario :

(i) With out limiting factor (non- attributable to a single product)

BEP in units = Fixed cost ÷ Average contribution p.u.

(when sales mix in units are given)

BEP in Rs. = Fixed cost ÷ composite p\v ratio

(when sales mix in rupee are given)

where composite p\v ratio = ÷ [Sales Mix ÷ P\V Ratio]

(ii) With limiting factor (attributable to a single product)

Find contribution per limiting factor & give rank . Find total contribution from 1st rank product . Calculate the amount of fixed cost still to recover. Whether it can be recovered by 2nd rank product or not ?

(iii) <u>For Perishable product</u> apply the same concept in case of opening stock with different variable cost.

e. BEP in case of process costing is expressed in terms of total raw material input

f. In capital budgeting , BEP is that sales volume where Sdiscounted Cash in flow = Sdiscounted Cash out flow. In case of perpetuity , the financing charge p.a.= CIF pa

g. Potential BE : On the basis of sales out of current period production only.

h. Multiple BE : Different BE due to change in sales price, variable costs & fixed costs for different production level.

i. Cash BEP = Cash fixed cost ¸ contribution p.u. So do not consider the sunk cost.

j. BEP for decision making purpose : Accept that proposal where BEP is lowest provided the profit can not be calculated.

3.2 IMPORTANT FACTORS IN MARGINAL COSTING DECISIONS

In all recommendations of marginal costing decisions, the following factors are to be considered:

(i) Whether the product or production line in question makes a contribution.

(ii) Where a choice is to be made between two courses of action, the additional fixed overhead, if any, should be taken into account.

(iii) The continuity of demand after expansion or renovation or installation of the sophisticated machine and its impact on the selling price should also be considered. For example, if the selling price goes down when the supply increases the possible drop in profit should be taken into account.

(iv) Cost is not the only criterion for decision making. Non-cost factors like the necessity to retain the experienced employees, etc. should also be considered.

3.3 PRICING DECISIONS UNDER SPECIAL CIRCUMSTANCES

If goods were sold in the normal circumstances under normal business conditions, the price would cover the total cost plus a margin of profit. Selling prices are not always determined by the cost of production. They may be determined by market conditions but in the long run they tend to become equal to the cost of production of marginal firm. Therefore, a business cannot continue to sell below the total cost for a long period. Occasionally, a firm may have to sell below the total cost.

*The **problem of pricing** can be summarised under three heads:*

(i) Pricing in periods of recession,

(ii) Differential selling prices, and

(iii) Acceptance of an offer and submission of a tender.

3.3.1 Pricing in periods of recession : In periods of recession, a firm may sell its articles at a price *less than the total cost but above the marginal cost* for a limited period.

The advantages of this practice are:

(i) The firm can continue to produce and use the services of skilled employees who are well trained and will be difficult to re-employ later if discharged.

(ii) Plant and machinery can be prevented from deterioration through idleness.

(iii) The business would be ready to take advantage of improved business conditions later.

(iv) This avoids the competition of securing the business of the firm.

One thing to remember here is that a situation like this should not lead to a drastic price cutting and the orders accepted should not cover a long period extending over the production facilities of a period when business conditions improve.

It may also be justifiable to sell the product at a price below marginal cost for a limited period provided the following conditions prevail:

(i) Where materials are of perishable nature.

(ii) Where stocks have been accumulated in large quantities and the market prices have fallen. This will save the carrying cost of stocks.

(iii) Is it essential to reduce the prices to such an extent in order to popularise a new product?

(iv) Where such reduction enables the firm to boost the sales of other products having larger profit margin.

3.3.2 Differential selling prices : Use of differential selling price which is above, the marginal cost but below the total cost is resorted to in order to absorb surplus capacity. There are two ways of doing this:

(i) The firm producing a branded article may use the surplus capacity to produce the same article to be sold above marginal cost in a different market.

Dumping of goods in the export market is an example of this type of pricing.

The articles sold in the home market will recover all fixed expenses. Since price reduction in the home market is injurious to the normal sales, it is not resorted to. Any reduction in the selling prices in the export market will not affect the price prevailing in the home market.

(ii) The firm may produce and sell a branded article, say product A, which covers the entire fixed overheads and use the surplus capacity to produce another product B, which may be sold at a price above its marginal cost. The overall profitability will thus increase. The manufacture of product B, however, should be confined to surplus capacity and it should not have the possibility of becoming a major product at the low price at which it is sold. If it becomes so there will be a reduction in profit as illustrated below :

Example

	Condition 1		*Condition 2*	
	Product A	Product B	Product A	Product B
Capacity	90%	10%	60%	40%
Sales	9,000	2,000	6,000	8,000
Marginal cost	6,000	1,800	4,000	7,200
Gross margin	3,000	200	2,000	800
Fixed expenses	2,000	—	2,000	—
Profit	1,000	200	—	800
Total profit	1,200		800	

Surplus capacity is assumed to be 10% in the above example.

3.3.3 Acceptance of an offer and submission of a tender

◆ **Acceptance of an offer** *:* When a firm having surplus capacity receives an offer from a special or export market, a decision as to whether to accept or not to accept the offer can be taken after the analysis of the *incremental cost and incremental revenue*.

Illustration : Decision on incremental cost and incremental revenue.

Capacity	*Unit cost*	*Unit selling price*
	Rs.	Rs.
6,000	80	100
7,000	75	97
8,000	74	95
9,000	72	
10,000	71	

The firm is operating at 8,000 units capacity and has received an order for 2,000 units from an export market at a price of Rs. 70 per unit. Advise the firm as to whether the export order should be accepted or not.

Solution

Apparently the unit cost at 9,000 and 10,000 units capacity is Rs. 72 and Rs. 71 respectively and since the export order is at Rs. 70 per unit, the order is not profitable. But this is a wrong approach. Let us tabulate the figures again and see the result.

Capacity	*Unit cost* Rs.	*Total cost* Rs.	*Incremental cost* Rs.	*Unit price* Rs.	*Total sales value* Rs.	*Incremental revenue* Rs.
6,000	80	4,80,000		100	6,00,000	
7,000	75	5,25,000	45,000	97	6,79,000	79,000
8,000	74	5,92,000	67,000	95	7,60,000	81,000
9,000	72	6,48,000	56,000			
10,000	71	7,10,000	62,000			

At 8,000 level of output the total sales revenue is Rs. 7,60,000 and the total cost is Rs. 5,92,000 leaving a profit of Rs. 1,68,000. The fact that this level of output leaves a profit means that the fixed expenses have been recovered already. Hence we have to take only the incremental cost for further levels of output. For an additional sales of 2,000 units the incremental cost is Rs. 7,10,000 – Rs. 5,92,000 = Rs. 1,18,000. The cost per unit, therefore, is $\frac{\text{Rs. } 1,18,000}{2,000 \text{ units}}$ = Rs. 59 for which the price quoted is Rs. 70 per unit. The offer is, therefore, acceptable.

◆ **Submission of Tenders:** For submitting tenders also the incremental cost and incremental revenue approach is useful. Considering the above example, if the firm operates at 8,000 level

of output, and quotations are to be given, any price quotation above the unit incremental cost of Rs. 59 would be profitable.

Illustration

All Play and Nowork Ltd. are specialists in the manufacture of sports goods. They manufacture croquet mallets but purchase the wooden balls, iron arches and stakes required to complete a croquet set.

Mallets consist of a head and handle. Handles use 1.5 board feet per handle at Rs. 40 per board foot. Spoilage loss is negligible for the manufacture of handles.

Heads frequently split and create considerable scrap. A head requires 0.20 board feet of high quality lumber costing Rs. 70 per board foot. Spoilage normally works out to 20% of the completed heads. 4% of the spoiled heads can be salvaged and sold as scrap at Rs. 10 per spoiled head.

In the department machining and assembling the mallets, 12 men work 8 hours per day for 25 days in a month. Each worker can machine and assemble 15 mallets per uninterrupted 50 minutes time frame. In each 8 hours working day, 15 minutes are allowed for coffee-break, 8 minutes on an average for training and 9 minutes for supervisory instructions. Besides 10% of each day is booked as idle time to cover checking in and checking out changing operations, getting materials and other miscellaneous matters. Workers are paid at a comprehensive rate of Rs. 6 per hour.

The department is geared to produce 40,000 mallets per month and the monthly expenses of the department are as under:

	Rs.
Finishing and painting of the mallets	50,800
Lubricating oil for cutting machines	300
Depreciation for cutting machine	700
Repairs and maintenance	100
Power to run the machines	200
Plant Manager's salary	2,700
Other overheads allocated to the department	1,20,000

As the mallets are machined and assembled in lots of 500, prepare a total cost sheet for one lot and advise the management on the selling price to be fixed per mallet in order to ensure a minimum 20% margin on the selling price.

Solution

All Play and Nowork Ltd.

Cost Sheet of one lot of 500 Croquet Mallets

Direct material:	Rs.	Rs.	Rs.
Handles (1.5 feet × 500 units × Rs. 40)		30,000	
Heads (1.20 × 500 × 0.20 × Rs. 70)	8,400		
(Refer to working note 1)			
Less: Scrap recovery			
(4% × 100 × Rs. 10)	40	8,360	38,360
Direct labour:			
$\left(\frac{8 \text{ hrs.} \times \text{Rs. } 6}{120} \times 500\right)$ *(Refer to working note 2)*			200
Prime cost			38,560
Factory & other overheads:			
Variable			
Finishing & painting			
$\left(\frac{\text{Rs. } 50,800}{40,000} \times 500\right)$ *(Refer to working note 3)*			635
Fixed			
$\left(\frac{\text{Rs. } 1,24,000}{36,000} \times 500\right)$ *(Refer to working note 4)*			1,722
Total cost			40,917
Price quotation:			
Cost per mallet $\left(\frac{\text{Rs. } 40,917}{500 \text{ units}}\right)$			81.834
Add: Profit 25% on cost			20.458
(20% margin on selling price means 25% on cost)			
Selling price			102.29

Working notes:

1. Since 20% of completed heads are spoiled, output of 1 unit requires input of 1 + 0.20 = 1.20 units; so, total heads processed: 1.20 × 500 = 600, of which spoiled heads are 100.

2. Total time in a day: 8 × 60 — 480 minutes

Less : Idle time	48 minutes	
Coffee break	15 minutes	
Instructions	9 minutes	
Training	8 minutes	80 minutes
Productive time per day:		400 minutes

Therefore, mallets to be produced per man per day : $\left(\frac{400}{50} \times 15\right)$ = 120 units.

Since mallets are produced at the rate of 120 mallets per man day, so total monthly production will be: 120 units × 12 men × 25 days = 36,000 mallets.

3. Finishing and painting overheads are assumed to be variable for the production of 40,000 mallets.

4. All the other expenses are fixed and are to be absorbed by 36,000 mallets of monthly production.

Illustration : Quotation for an export order

Somesh of Agra presently operates its plant at 80% of the normal capacity to manufacture a product only to meet the demand of Government of Tamil Nadu under a rate contract.

He supplies the product for Rs. 4,00,000 and earns a profit margin of 20% on sales realisations. Direct cost per unit is constant.

The indirect costs as per his budget projections are :

Indirect costs	*20,000 units (80% capacity) Rs.*	*22,500 units (90% capacity) Rs.*	*25,000 units (100% capacity) Rs.*
Variable	80,000	90,000	1,00,000
Semi-variable	40,000	42,500	45,000
Fixed	80,000	80,000	80,000

He has received an export order for the product equal to 20% of its present operations. Additional packing charges on this order will be Rs. 1,000.

Arrive at the price to be quoted for the export order to give him a profit margin of 10% on the export price.

Solution

Working Notes :

1. Direct Cost per unit

	Rs.
Selling price per unit (Rs. 4,00,000/20,000 units)	20
Less : Profit margin (20% × Rs. 20/-)	4
Total cost	16
Less: Indirect costs (Rs. 2,00,000/20,000 units)	10
Direct cost per unit	6

2. Statement of differential cost for 4,000 units

(20% of 20,000 units)

	Present production 20,000 units Rs.	*Proposed production 24,000 units Rs.*	*Differential cost for 4,000 units Rs.*
Direct cost @ Rs. 6/- p.u.	1,20,000	1,44,000	24,000
Indirect cost:			
Variable @ Rs.4/- p.u.	80,000	96,000	16,000
Semi-variable	40,000	44,000	4,000
Fixed	80,000	81,000	1,000
Total	3,20,000	3,65,000	45,000

Computation for the price to be quoted for the export order of 4,000 units

	Rs.
Differential cost *(Refer to working note 2)*	45,000
Add : Profit (10% of export price or 1/9th of cost)	5,000
Price to be quoted	50,000

Export price per unit : Rs. 12.50

(Rs. 50,000/4000 units)

Illustration : Whether to accept an offer

A Company can produce and sell at its maximum capacity 20,000 units of a product. The sale of price is Rs. 100. The present sales is 15,000 units. To produce over 20,000 units and upto another 10,000 units some balancing equipments are to be installed at a cost of Rs. 10 lakhs and the same will have a life span of 10 years.

The current cost structure is as under :

Direct material	30% of sale value
Direct labour	20% of sale value
Variable overheads	Rs. 20 per unit
Profit	Rs. 15 per unit

The present cost is estimated to go up due to price escalation as under :

10% in Direct material from present level of 30%

25% in Direct labour from present level of 20%

Rs. 50,000 in Fixed overheads per year.

There is a concrete proposal from a party to take 10,000 units additionally over the present level of output on a long-term basis at a unit price of Rs. 90. Apart from the investment of Rs. 10 lakhs, as shown above, the fixed overheads will increase by Rs. 50,000 due to additional Administrative expenses.

The Company is in a dilemma as to whether to accept the order for 10,000 units or to use the present unused capacity of 5,000 units for which there will be additional selling expenditure of Rs. 50,000.

Ignore financing charges and give your recommendation.

Solution

Working Note :

Fixed overheads :	Rs.
Present sale value: (A)	15,00,000
(*15,000 units* × *Rs. 100*)	
Direct materials	4,50,000
(*30% of sale value*)	
Direct labour	3,00,000
(*20% of sale value*)	

Variable overheads (*Rs. 20 per unit*)	3,00,000
Total variable costs: (B)	10,50,000
Contribution: (C) : (A) – (B)	4,50,000
Profit : (D) (*15,000 units* × *Rs. 15*)	2,25,000
Fixed overheads: (C) – (D) (*current level*)	2,25,000
Add: Additional fixed overheads due to price escalation	50,000
Total fixed overheads	2,75,000

Statement of profitability for various alternatives

Alternatives	*I*	*II*	*III*	*IV*
	Rejecting the proposal for the purchase of 10,000 units and continuing with present level of sales only	*Rejecting the proposal for the purchase of 10,000 units from a party and attaining the maximum capacity by incurring additional selling expenditure*	*Accepting the proposal of the party to take 10,000 units @ Rs. 90 per unit by installing a balanc-ing equipment and continuing with pre-sent level of sales*	*Accepting the proposal of party to take 10,000 units @ Rs. 90 per unit by installing a balancing equipment and attaining sale of maximum avail-able capacity by incur-ring additional selling expenditure*
Sales (units)	15,000	20,000	25,000	30,000
	Rs.	Rs.	Rs.	Rs.
Sales value: (A)	15,00,000 (15,000 × Rs. 100)	20,00,000 (20,000 × Rs. 100)	24,00,000 (15,000 × Rs. 100 + 10,000 × Rs. 90)	29,00,000 (20,000 × Rs. 100 + (10,000 × Rs. 90)
Variable costs :				
Direct materials (33% of sales value)	4,95,000	6,60,000	8,25,000*	9,90,000*
Direct labour (25% of sale value)	3,75,000	5,00,000	6,25,000*	7,50,000*
Variable overheads (@ Rs. 20 per unit)	3,00,000	4,00,000	5,00,000	6,00,000
Total variable costs : (B)	11,70,000	15,60,000	19,50,000	23,40,000

Fixed costs :				
Fixed overheads *(Refer to working note)*	2,75,000	2,75,000	2,75,000	2,75,000
Additional selling expenditure	—	50,000	—	50,000
Depreciation for balancing equipment	—	—	1,00,000	1,00,000
Additional adminis-trative expenses	—	—	50,000	50,000
Total fixed costs : (C)	2,75,000	3,25,000	4,25,000	4,75,000
Total costs D : [(B)+ (C)]	14,45,000	18,85,000	23,75,000	28,15,000
Profit : (A)–(D)	55,000	1,15,000	25,000	85,000

*** Note :** For computing the material and labout cost under alternatives III & IV the notional sale price of Rs. 100 is taken for additional 10,000 units.

Recommendations : Alternative II is the best as it gives maximum profit.

Illustration : Fixing Price

R Ltd. will produce 3,00,000 kgs. of S and 6,00,000 kgs. of Y from an input of 9,00,000 kgs. of raw material Z.

The selling price of S is Rs. 8 per kg and that of Y is Rs. 6 per kg.

Processing costs amount to Rs. 54 lacs per month as under:

Raw material Z 9,00,000 kgs. at Rs. 3 per kg	Rs.27,00,000
Variable processing costs	Rs.18,00,000
Fixed processing costs	Rs. 9,00,000
Total	54,00,000

There is an offer to purchase 60,000 kgs of Y additionally at a price of Rs. 4 per kg. The existing market for Y will not be affected by accepting the offer. But the price of S is likely to be decreased uniformly on all sales.

Find the minimum reduced average price for S to sustain the increased sales.

Solution

Since S and Y are produced simultaneously from an input of raw material Z, therefore when additional 60,000 kgs of Y will be produced then 30,000 kgs. of S will also be produced simultaneously. The input of material Z required for these additional 60,000 kgs of Y and 30,000 kgs. of S will be 90,000 kgs. of material Z. Hence the cost of processing 90,000 kgs. of material will be as follows :

	Rs.
Cost of Raw material Z *(90,000 kgs × Rs.3)*	2,70,000
Variable processing cost *(90,000 kgs × Rs.2)*	1,80,000
Total cost of processing	4,50,000
Less : Sales revenue from 60,000 kgs. of Y (*60,000 kgs × Rs. 4*)	2,40,000
Balance cost to be recovered	2,10,000
Current sales revenue from the sale of 3,00,000 kgs. of S (*3,00,000 kgs.× Rs.8*)	24,00,000
Total sales revenue to be earned from the sale of S (*3,00,000 kgs. + 30,000 kgs.*)	26,10,000
Hence minimum price per kg of S to recover Rs. 26,10,000 from the sale of 3,30,000 kgs. of S (Rs.26,10,000/3,30,000 kgs.)	7.91

3.4 MAKE OR BUY DECISION

Very often management is faced with the problem as to whether a part should be manufactured or it should be purchased from outside market. Under such circumstances two factors are to be considered:

(a) whether surplus capacity is available, and

(b) the marginal cost.

Illustration : Make or Buy decision

The total cost of a manufactured component is as under:

Prime cost	Rs. 15	Fixed overhead	Rs. 4
Variable overhead	Rs. 7	Total cost	Rs. 26

The same part is available in the market at Rs. 23. Should the firm make it or buy it?

Solution

If surplus capacity is available and will remain idle if the component is bought, the out of pocket expenses will be Rs. 23 per unit. Re. 1 more than the variable (relevant) cost of making component which is Rs. 22 (Rs. 15 + Rs. 7). Hence, it is economical to make it. However, if the firm is utilizing or can utilize the capacity in making some other part which

contributes, say Rs. 4 per unit, the effective cost of buying the component will be Rs. 19 (Rs. 23 less Rs. 4 contribution from other product). In that case, it would be economical to buy the component at Rs. 23 per unit from outside. The relevant computations for taking decision may be as follows:

	Make	*Per unit cost Buy and leave capacity idle*	*Buy and use capacity for other product*
	Rs.	*Rs.*	*Rs.*
Cost of making/buying	(22)	(23)	(23)
Contribution from other product	—	—	4
Net relevant cost	(22)	(23)	(19)

Illustration : Selection of Machine

Perfect Product Ltd. is currently buying a component from a local supplier at Rs. 15 each. The supply is tending to be irregular. Two proposals are under consideration:

1. Buy and install a semi-automatic machine for manufacturing this component, which would involve an annual fixed cost of Rs. 9 lakhs and a variable cost of Rs. 6 per manufactured component.
2. Buy and install an automatic machine for manufacturing this component, incurring an annual fixed cost of Rs. 15 lakhs and a variable cost of Rs. 5 per manufactured component.

Determine with necessary computations:

(1) The annual volume required, in each case, to justify a switch over from outside purchase to 'own manufacture'.

(2) The annual volume required, to justify selection of the automatic machine instead of the semi-automatic machine.

(3) If the annual requirement of the coming year is expected to be 5,00,000 Nos. and the volume is expected to increase rapidly thereafter, would you recommend the automatic or semi-automatic machine. Justify your recommendation.

Solution

(1)

	Proposal 1 Semi-automatic Machine	*Proposal 2 Automatic Machine*
	Rs.	*Rs.*
Purchase cost per unit for the component now being bought	15	15

Less : Unit variable cost for 'own manufacture'	6	5
Unit contribution from 'own manufacture'	9	10
Total annual fixed cost to be recouped	9,00,000	15,00,000
Number of units required to fully recover the amount	1,00,000 Nos.	1,50,000 Nos.

These figures show that an annual volume of over 1,00,000 Nos. of the component will justify 'own manufacture' on the semi- automatic machine, instead of purchase from outside.

To justify the installation of the automatic machine, the quantity required is an annual volume of over 1,50,000 Nos.

(2) Incremental annual fixed cost if automatic machine is chosen : Rs. 6,00,000

Saving in unit variable cost by choosing the automatic machine : Re. 1

Production volume required to recover the additional annual fixed costs through saving in unit variable cost. 6,00,000 Nos.

For annual requirements of over 6,00,000 units of the components, the automatic machine will be more economical as compared to the semi-automatic machine.

(3) If the annual requirement is 5,00,000 units, the semi-automatic machine is to be preferred, as it would involve a lower total cost per unit of the component, as indicated below :

	Semi-automatic	*Automatic*
	Rs.	*Rs.*
Total variable costs:		
5,00,000 units @ Rs. 6 and Rs. 5 respectively	30,00,000	25,00,000
Total fixed costs	9,00,000	15,00,000
Total costs	39,00,000	40,00,000
Total cost per unit	7.80	8.00

However, the annual requirement is expected to increase rapidly beyond 5,00,000 units; as soon as it is 6,00,000 units the semi-automatic machine will become more expensive as compared to the automatic machine. Then the need for installing the automatic machine will arise which may be within a very short period after commissioning the semi-automatic machine. Replacement of the semi-automatic machine by an automatic machine may then become costly, not only because of the loss that may arise on the semi- automatic machine but also by possibly a higher price of the automatic machine. The management may therefore, install an automatic machine immediately.

Illustration : whether to work in extra shift

Agrocaps Ltd., in manufacturing agricultural machinery, is preparing its annual budget for the coming year. The company has a metal pressing capacity of 20,000 hours, which will be insufficient for manufacture of all requirements of components A, B, C and D.

The company has the following choices:

(i) Buy the components entirely from outside suppliers.

(ii) Buy from outside suppliers and/or use a partial second shift.

The data for the current year are given below:

Standard production cost per unit

Component	A	B	C	D
	Rs.	Rs.	Rs.	Rs.
Variable cost:				
Direct materials	37	27	25	44
Direct wages	10	8	22	40
Direct expenses	10	20	10	60
Fixed overhead	5	4	11	20
Total production cost p.u.	62	59	68	164
Requirements in units	2,000	3,500	1,500	2,800

Direct expenses relate the use of the metal presses which cost Rs. 10 per hour, to operate. Fixed overheads are absorbed as a percentage of direct wages.

Supply of all or any part of the total requirement can be obtained at following prices, each delivered to the factory:

Component	*Rs.*
A	60
B	59
C	52
D	168

Second shift operations would increase direct wages by 25 percent over the normal shift and fixed overhead by Rs. 500 for each 1,000 (or part thereof) second shift hours worked.

You are required to present, with calculations:

(a) Which component, and in how much quantities should it be manufactured in the 20,000 hours of press time available?

(b) Whether it would be profitable to make any of the balance of components required on a second shift basis instead of buying them from outside suppliers.

Solution

(a) Working notes :

(i) Process hours required

Component	*A*	*B*	*C*	*D*
	Rs.	*Rs.*	*Rs.*	*Rs.*
Direct expenses per unit	10	20	10	60
No. of press hours per unit, direct expenses per press hour being Rs. 10	1	2	1	6

(ii) Marginal cost of production per unit vs. bought out prices per unit

Component	*A*	*B*	*C*	*D*
	Rs.	*Rs.*	*Rs.*	*Rs.*
Marginal (variable) costs				
Direct material	37	27	25	44
Direct wages	10	8	22	40
Direct expenses	10	20	10	60
Marginal cost per unit : (A)	57	55	57	144
Bought out price : (B)	60	59	52	168
Excess of bought out price over marginal cost : {(B) – (A)}	3	4	(5)	24
Press hours per unit	1	2	1	6
Excess of bought out price per unit of limiting factor (i.e. press hour)	3	2	(5)	4

The bought-out price for component C is lower by Rs. 5 than the marginal cost of production and so it should be purchased from outside.

In case the remaining components A, B and D are bought, their ranking in terms of loss per unit of limiting factors (press hour) would be D (highest loss per unit), A and B. The capacity available should, therefore, be deployed for making D first and then A and thereafter B.

Components and their quantities to be manufactured in 20,000 hours of press time available (single shift operation)

		Hours
Available capacity for metal pressing		20,000
First, produce D hours required (2,800 units × 6 hours)	16,800	
Balance hours available		3,200
Second, produce A hours required (2,000 units × 1 hour)	2,000	
Balance hours available		1,200
Third, produce B, for the balance hours available (600 units × 2 hours)		1,200
Balance hours available		Nil

So, in 20,000 hours of press time available, all the requirements of components D and A and only 600 units of component B can be manufactured. The balance requirement of component B i.e. 2,900 (3,500 – 600) units will have to be bought out or manufactured in the second shift.

(b) Since the purchase price of Component C (i.e. Rs. 52) is lower than the marginal cost of manufacturing (i.e. Rs. 57) in even single shift, it will not be profitable to make it, hence it should be purchased from outside.

Now it is to be seen whether 2,900 units of B should be produced in the second shift or bought from outside. The comparative position is given below:

Cost of producing 2,900 units of components B in second shift	Rs.
Variable cost per unit on single shift basis	55.00
Add. Increase in direct wages per unit	2.00
Variable cost per unit	57.00
Total variable cost for 2,900 units, (2,900 units × Rs. 57)	1,65,300
Additional fixed cost :	
Hours required for 2,900 units of B (2900 units × 2 hours) = 5,800 hrs.	
Extra fixed cost for 5,800 hours at Rs. 500 for	
every 1,000 hours (or part thereof)	3,000
Total cost for producing 2,900 units of B in second shift : (A)	1,68,300
Bought outside price for 2,900 units of B will be 2,900 units × Rs.59:(B)	1,71,100
Disadvantage in buying : (A – B)	(2,800)

Since the cost of manufacturing balance quantity of component B i.e. 2,900 in second shift is less by Rs. 2,800, it is profitable to make it on a second shift basis instead of buying it from outside suppliers.

Illustration : Profit Maximization

A company manufacturing a highly successful line of cosmetics intends to diversify the product line to achieve fuller utilisation of its plant capacity. As a result of considerable research made, the company has been able to develop a new product called "EMO".

EMO is packed in tubes of 50 gram capacity and is sold to the wholesellers in cartons of 24 tubes at Rs. 240 per carton. Since the company uses its spare capacity for the manufacture of EMO, no additional fixed expenses will be incurred. However the cost accountant has allocated a share of Rs. 4,50,000 per month as fixed expenses to be absorbed by EMO as a fair share of the company's present fixed costs to the new product for costing purposes.

The company estimates the production and sale of EMO at 3,00,000 tubes per month and on this basis the following cost estimates have been developed:

	Rs. per carton
Direct materials	108
Direct wages	72
Overheads	54
Total costs	234

After a detailed market survey the company is confident that the production and sales of EMO can be increased to 3,50,000 tubes per month and ultimately to 4,50,000 tubes per month.

The company at present has a capacity for the manufacture of 3,00,000 empty tubes and the cost of the empty tubes if purchased from outside will result in a saving of 20% in material and 10% in direct wages and variable overhead costs of EMO. The price at which the outside firm is willing to supply the empty tubes is Rs. 1.35 per empty tube. If the company desires to manufacture empty tubes in excess of 3,00,000 tubes, a new machine involving an additional fixed overheads of Rs. 30,000 per month will have to be installed.

Required :

(i) State by showing your workings whether the company should make or buy the empty tubes at each of the three volumes of production of EMO namely, 3,00,000; 3,50,000 and 4,50,000 tubes.

(ii) At what volume of sales will it be economical for the company to install the additional equipment for the manufacture of empty tubes?

(iii) Evaluate the profitability on the sale of EMO at each of the aforesaid three levels of output based on your decision and showing the cost of empty tubes as a separate element of cost.

Solution

(i) Working notes :

		Rs.
(1)	Overheads for one carton i.e. 24 tubes	54
	Therefore, per tube overheads: (Rs. 54/24 tubes)	2.25

Fixed overheads allocated for 3,00,000 tubes: Rs. 4,50,000

Per tube fixed overheads: $\left(\frac{\text{Rs. } 4,50,000}{3,00,000 \text{ tubes}}\right)$ = Rs. 1.50

Therefore variable overheads, per tube {Rs. 2.25 – Rs. 1.50} = Re. 0.75.

		Rs.
(2)	Direct wages per carton	72
	Therefore, direct wages per tube : (Rs. 72/24 tubes)	3
(3)	Direct materials per carton	108
	Therefore, direct materials per tube : (Rs. 108/24 tubes)	4.50

(4) *Cost of making one empty tube:*

	Cost per tube of EMO	*Costs in respect of empty tube*	*Cost of empty tube*	*Cost per tube of EMO without empty tube*
	Rs.	Rs.	Rs.	Rs.
Direct materials	4.50	20	0.90	3.60
Direct wages	3.00	10	0.30	2.70
Variable overheads	0.75	10	0.075	0.675
	8.25		1.275	6.975

Cost of manufacturing / buying of 300,000 empty tubes of EMO

	Empty tube cost Rs.	*If empty tubes are made Rs.*	*If empty tubes are purchased Rs.*
Direct materials	0.90	2,70,000	—
Direct wages	0.30	90,000	—
Variable overheads	0.075	22,500	—
Purchase price	1.35	—	4,05,000
Total		3,82,500	4,05,000

Since manufacturing capacity is available for the manufacture of 3,00,000 empty tubes at a cost of Rs. 3,82,500 whereas the total cost of purchase of tubes is higher, i.e., Rs. 4,05,000, the company should manufacture the empty tubes for a production volume of 3,00,000 EMO tubes.

Beyond 3,00,000 empty tubes, the company has to install a new machine involving a total additional fixed overheads of Rs. 30,000. The cost of making and buying the additional tubes 50,000 and 1,50,000 units of empty tubes will be as under :

		Additional empty tubes			
		50,000 tubes		*1,50,000 tubes*	
	Per tube	*Make*	*Buy*	*Make*	*Buy*
	Rs.	Rs.	Rs.	Rs.	Rs.
Direct materials	0.90	45,000		1,35,000	—
Direct wages	0.30	15,000		45,000	—
Variable overheads	0.075	3,750		11,250	—
Additional overheads		30,000		30,000	—
Purchase price	1.35	—	67,500	—	2,02,500
Total		93,750	67,500	2,21,250	2,02,500

The above statement shows that the cost of buying additional empty tubes at both the levels is lower than the cost of their manufacture. Therefore, if the company increases production to 3,50,000 tubes of EMO, 3,00,000 tubes should be made in the factory and additional 50,000 tubes should be purchased at Rs. 67,500.

If the company increases production to 4,50,000 tubes of EMO, 3,00,000 empty tubes should be made in the factory and additional 1,50,000 tubes should be purchased at a cost of Rs. 2,02,500.

(ii) Additional fixed overheads to be incurred on a new machine: Rs. 30,000. Savings per unit if empty tubes are made in the factory instead of buying: Rs. 1.35 – Rs. 1.275 = Re. .075

Minimum additional quantity of empty tubes to be made to recover the additional fixed costs:

$$\frac{\text{Rs.}30{,}000}{\text{Rs. } 0.075} = 4{,}00{,}000 \text{ empty tubes}$$

Thus the company should sell 3,00,000 + 4,00,000 = 7,00,000 tubes of EMO per month to warrant justification for the installation of the new machine for the manufacture of empty tubes.

(iii) Evaluation of the profitability on sale of EMO at the three levels

	Per tube	*3,00,000 tubes*	*3,50,000 tubes*	*4,50,000 tubes*
	Rs.	Rs.	Rs.	Rs.
Sales (Rs. 240/24 tubes)	10	30,00,000	35,00,000	45,00,000
Direct materials	3.60	10,80,000	12,60,000	16,20,000
Direct wages	2.70	8,10,000	9,45,000	12,15,000
Variable overheads	0.675	2,02,500	2,36,250	3,03,750
Empty tubes made	1.275	3,82,500	3,82,500	3,82,500
Empty tubes purchased	1.35	—	67,500	2,02,500
Total costs		24,75,000	28,91,250	37,23,750
Profit		5,25,000	6,08,750	7,76,250

Illustration : Make or Buy Decision

A firm needs a component in an assembly operation. If it wants to do the manufacturing itself, it would need to buy a machine for Rs. 4 lakhs which would last for 4 years with no salvage value. Manufacturing costs in each of the 4 years would be Rs. 6 lakhs, Rs. 7 lakhs, Rs. 8 lakhs and 10 lakhs respectively. If the firm had to buy the component from a supplier the component would cost Rs. 9 lakhs, Rs. 10 lakhs, Rs. 11 lakhs and Rs. 14 lakhs respectively in each of the 4 years. However, the machine would occupy floor space which could have been used for another machine. This latter machine could be hired at no cost to manufacture an item, the sale of which would produce net cash flows in each of the 4 years of Rs. 2 lakhs; it is impossible to find room for both the machines and there are no other external effects. The cost of capital is 10% and PV factor for each of the 4 years is 0.909, 0.826, 0.751 and 0.683 respectively. Should the firm make the component or buy from outside?

Solution

Evaluation of Make or Buy Proposal

Rs. in lakhs

Year	*Present value factor* at 10%	*When the Component is manufactured*		*When the Component is bought*	
		Cash outflow	*Present value*	*Cash outflow*	*Present value*
0	1.000	4	4.000	—	—
1	.909	6 + 2	7.272	9	8.181

2	.826	7 + 2	7.434	10	8.260
3	.751	8 + 2	7.510	11	8.261
4	.683	10 + 2	8.196	14	9.562
			34.412		34.264

Saving in buying: Rs. 34.412 lakhs – Rs. 34.264 lakhs = Rs. 0.148 lakh

Thus it is beneficial to buy the component from outside.

Note : The loss of Rs 2 lakhs cash inflow for each of the 4 years due to inability of the firm to operate another machine when it manufactures the component is to be treated as an opportunity cost.

Illustration : Make or Buy decision

Product 'A' takes five hours to produce on a particular machine and it has a selling price of Rs. 50 and a marginal cost of Rs. 35.

On the same machine, another product 'B' can be made at two hours at a marginal cost of Rs. 5 per unit.

Supplier's price of product 'B' is Rs. 10 per unit.

Assuming that machine hour is the key factor, advise whether product 'B' could be bought out or manufactured.

Solution

	Rs.
Selling price per unit of product 'A'	50
Less: Marginal cost per unit	35
Contribution per unit	15
Contribution per hour of product 'A' (Rs. 15/5 hours)	3

Since one unit of product 'B' needs 2 hours, therefore if a unit of B is produced, then the contribution lost by not producing 'A' = 2 hours × Rs. 3 = Rs. 6

Real cost of producing one unit of product 'B'

	Rs.
Marginal cost per unit	5
Add: Contribution lost per unit	6
Total cost of producing a unit of Product 'B'	11

As the suppliers price per unit of product 'B' is Rs. 10 and that of producing in the factory is Rs. 11, therefore it is suggested that it is better to buy product 'B' from outside.

Illustration : Make or buy decision

A machine manufactures 10,000 units of a part at a total cost of Rs. 21 of which Rs. 18 is variable. This part is readily available in the market at Rs. 19 per unit.

If the part is purchased from the market then the machine can either be utilised to manufacture a component in same quantity contributing Rs. 2 per component or it can be hired out at Rs. 21,000.

Recommend which of the alternative is profitable.

Solution

1st alternative :

(*10,000 units of the part are manufactured internally*).

Variable cost of 10,000 units	
@ Rs. 18 p.u. (Rs.)	1,80,000

2nd alternative :

(*10,000 units of the part are purchased from the market and the machine is utilised to manufacture 10,000 units of a component contributing Rs.2/- per unit*)

Purchase cost of 10,000 units	
@ Rs.19/- p.u. (Rs.)	1,90,000
Less : Contribution received on the utilisation of machine time	
10,000 units × Rs. 2	20,000
	1,70,000

3rd alternative :

(*10,000 units of the part are purchased from outside and the machine time is hired out at Rs. 21,000*).

Purchase cost of 10,000 units	
@ Rs.19/- p.u. (Rs.)	1,90,000
Less : Rent received on hiring out the machine	21,000
	1,69,000

Recommendation :

Out of the above three alternatives, 3rd alternative is the best, as the cost of 10,000 required units under it is the lowest.

3.5 SHUT DOWN OR CONTINUE DECISION

Very often it becomes necessary for a firm to temporarily close down the factory due to trade recession with a view to reopening it in the future. In such cases, the decision should be based on the marginal cost analysis.

If the products are making a contribution towards fixed expenses or in other words if selling price is above the marginal cost, it is preferable to continue because the losses are minimised.

By suspending the manufacture, certain fixed expenses can be avoided and certain extra fixed expenses may be incurred depending upon the nature of the industry, say, for example, extra cost incurred in protecting the machinery. So the decision is based on as to whether the contribution is more than the difference between the fixed expenses incurred in normal operation and the fixed expenses incurred when the plant is shut down. In other words, the shut down point is calculated by using the formula:

$$\text{Shut down point} = \frac{\text{Total fixed cost} - \text{Shut down costs}}{\text{Contribution per unit}}$$

Illustration

	Rs.
Fixed expenses at 50% activity	15,000
Fixed expenses when the factory is shut down	10,000
Additional expenses in closing down	1,000

Production at 50% activity = 5,000 units

Contribution per unit Re. 1

Solution

		Rs.
A.	If the plant is shut down the sunk costs or fixed expenses	11,000
B.	If it is working at 50% activity the fixed expenses	15,000
C.	Additional fixed expenses : [(B) – (A)]	4,000
D.	Contribution (5,000 units × Re. 1 p.u.)	5,000

By working at 50% activity the firm is able to recover the additional fixed expenses of Rs. 4,000 and earn an extra contribution of Rs. 1,000 towards shut down expenses. Hence it is advisable to continue production in the factory instead of closing it down. If, on the other hand, the contribution is Re. 0.75 per unit, the total contribution of Rs. 3,750 being less than the additional fixed expenses, it is not advisable to continue the operations. Hence in the latter case shut down is economically justified.

Illustration

Alfa Engineering Works Ltd. had the following annual budget for the year ending on 30th June, 1999

Production Capacity	*60%*	*80%*
Costs (Rs. lakhs):		
Direct materials	9.60	12.80
Direct labour	7.20	9.60
Factory expenses	7.56	8.04
Administrative expenses	3.72	3.88
Selling and distribution expenses	4.08	4.32
Total cost	32.16	38.64
Profit	4.86	10.72
Sales	37.02	49.36

Owing to adverse trading conditions, the Company has been operating during July/September 19 - at 40% capacity, realising budgeted selling prices.

Owing to acute competition, it has become inevitable to reduce prices by 35% even to maintain the sales at the existing level. The directors are considering whether or not their factory should be closed down until the trade recession has passed. A market research consultant has advised that in about a year's time there is every indication that sales will increase to 75% of normal capacity and that the revenues to be produced for a full year at that volume could be expected to Rs. 40 lakhs.

If the directors decide to close down the factory for a year it is estimated that :

(a) the present fixed costs would be reduced to Rs. 6 lakhs per annum;

(b) closing down costs (redundancy payments, etc.) would amount to Rs. 2 lakhs.

(c) necessary maintenance of plant would cost Rs. 50,000 per annum; and

(d) on re-opening the factory, the cost of overhauling the plant, training and engagement of new personnel would amount to Rs. 80,000.

Prepare a report for the directors, making your recommendations.

Solution

The Directors,

Alfa Engineering Works Ltd.

New Delhi

Dear Sir,

As desired, we have analysed the cost implications of the decision of temporary closure of the trade recession. We find that if the factory is run at 40% capacity and with reduced selling prices, the loss likely to be incurred in one full year (the estimated period of recession), would be around Rs. 7.17 lakhs as detailed below:

	Rs. (in lakhs)
Direct materials	6.40
Direct labour	4.80
Factory expenses	7.08
Administrative expenses	3.56
Selling & distribution expenses	3.84
	25.68
Loss	7.17
Sales $\left(\text{Rs. } 37.02 \text{ lakhs} \times \frac{40}{60} \times \frac{75}{100}\right)$	18.51

If the factory is closed, the following costs will be incurred:

	Rs. (in lakhs)
Fixed costs	6.0
Closing down costs	2.0
Maintenance costs	0.5
Cost of overhauling the plant, training and engagement of staff	0.8
	9.3

It is obvious from the above, that despite the fact that running at 40% capacity would imply a loss of Rs. 7.17 lakhs, it is better not to close down the factory since in that case the loss would be higher.

In our views, even if running the factory entailed a somewhat bigger loss as compared to the loss incurred by closing it down temporarily, it may be better to keep the factory in operation. This is because a closure, even if temporary, results in the loss of regular and old customers, suppliers and skilled personnel. This, coupled with a loss of goodwill in the market, may give rise to substantial losses at the time of restarting the factory.

We trust that the above analysis would be helpful to you in reaching an appropriate decision in the matter. We shall be glad to be of any further assistance that may be required in this regard.

Yours faithfully,

X & Co.

Chartered Accountants.

Working note:

	Factory expenses (Rs. lakhs)	*Admn. expenses (Rs. lakhs)*	*Selling expenses (Rs. lakhs)*
(i) Amount at 60%	7.56	3.72	4.08
(ii) Amount at 80%	8.04	3.88	4.32
(iii) Change for 20%	0.48	0.16	0.24
(iv) Amount at 40% (i) – (iii)	7.08	3.56	3.84

Illustration

A paint manufacturing company manufactures 2,00,000 per annum medium-sized tins of "Spray Lac Paints" when working at normal capacity. It incurs the following costs of manufacturing per unit :

	Rs.
Direct material	7.80
Direct labour	2.10
Variable overhead	2.50
Fixed overhead	4.00
Product cost (per unit)	16.40

Each unit (tin) of the product is sold for Rs. 21 with variable selling and administrative expenses of 60 paise per tin.

During the next quarter only 10,000 units can be produced and sold. Management plans to shut down the plant estimating that the fixed manufacturing cost can be reduced to Rs. 74,000 for the quarter.

When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shut-down for the quarter are estimated at Rs. 14,000.

You are required:

(a) To express your opinion, along with the calculations, as to whether the plant should be shut down during the quarter, and

(b) To calculate the shut down point for quarter in units of products (i.e., in terms of number of tins).

Solution

(a) Working note:

Contribution per tin:

Selling price – Variable cost of the product

= Rs. 21 – Rs. (7.80 + 2.10 + 2.50 + 0.60)

= Rs. 8 per tin

Calculation of loss, if plant is operated

	Rs.
Total contribution on 10,000 tins @ Rs. 8 each	80,000
Less: Total fixed cost for three months	
(2,00,000 × Rs. 4) × $\frac{3}{12}$	2,00,000
Expected loss on operation	(1,20,000)

Calculation of loss (shut down costs) if plant is shut down

	Rs.
Unavoidable fixed cost	74,000
Additional cost of shut-down	14,000
Total loss on shut down	(88,000)

It is clear from the above, that if plant is operated, loss would be Rs. 1,20,000 which exceeds the loss by Rs. 32,000 (Rs. 1,20,000 – Rs. 88,000) when the plant is shut-down. Therefore, the management should shut-down the plant during the quarter.

(b) Calculation of shut-down point

Avoidable fixed cost for the period (or fixed cost which will not be incurred if the plant is shut down) :

= Total fixed cost for the period – (Unavoidable fixed costs + Additional shut down costs)

= Rs. 2,00,000 – (Rs. 74,000 + Rs. 14,000)

= Rs. 2,00,000 – Rs. 88,000

= Rs. 1,12,000

$$\textit{Shut-down point} = \frac{\text{Avoidable fixed cost}}{\text{Contribution per unit}}$$

$$= \frac{Rs.\,1,12,000}{Rs.\,8} = 14,000 \text{ tins}$$

or

$$\textit{Shut-down point} = \frac{\text{Total fixed cost} - \text{Shut down costs}}{\text{Contribution per unit}}$$

$$= \frac{\text{Rs. } 2,00,000 - \text{Rs. } 88,000}{\text{Rs. } 8} = 14,000 \text{ tins}$$

♦ **Other considerations in shut down decisions :** Cost is not the only criterion for deciding in favour of shut down. Non-cost factors worthy of consideration in this regard are :

1. Interest of the workers —if the workers are discharged it may become difficult to get skilled workers later, on reopening of the factory. Also shut down may create problem for the workers which may far exceed the cost benefits of the shut down.
2. Once the firm is closed down competitors may establish their products and thus it may be difficult to introduce the product in the market again.
3. The plant may become obsolete or depreciate at a larger rate when not in operation. Thus, heavy capital expenditure may have to be incurred on re-opening.

Illustration

Universe Ltd. manufactures 20,000 units of 'X' in a year at its normal production capacity. The unit cost as to variable costs and fixed costs at this level are Rs.13 and Rs.4 respectively.

Due to trade depression, it is expected that only 2,000 units of 'X' can be sold during the next year. The management plans to shut-down the plant. The fixed costs for the next year then is expected to be reduced to Rs. 33,000. Additional costs of plant shut-down are expected at Rs. 12,000. Should the plant be shut-down ? What is the shut-down point ?

Solution

Note : The decisions regarding the plant to shut-down and the calculation of shut-down point requires the figure of selling price per unit of the units sold. As the statement of the question fails to indicate the selling price (per unit) therefore one is free to assume it.

Assumption : *Let's assume the Selling Price per unit be Rs. 20*

Statement of cost for taking a decision about shut-down of plant

	Plant is operated	*Plant is shut down*
	Rs.	*Rs.*
Variable Cost	26,000	–
	(2,000 units × Rs. 13)	
Fixed Costs	80,000	33,000
	(20,000 units × Rs. 4)	(unescapable cost)
Additional shut down cost	–	12,000
Total Cost	1,06,000	45,000
State of loss :		
Sales	40,000	–
	(2,000 units × Rs. 20)	
Less : Total Cost (as above)	1,06,000	45,000
Loss	(66,000)	(45,000)
	(if continued)	(if shut-down)

Recommendation : A comparison of loss figures indicated as above points out, that, loss is reduced if the plant is shut-down. In fact by doing so the concern's loss would be reduced by (Rs. 21,000).

Calculation of Shut down point :

$$\text{Shut–down point} = \frac{\text{Total fixed cost} - \text{Shut down costs}}{\text{Contribution per unit}}$$

$$= \frac{\text{Rs. } 80{,}000 - \text{Rs. } 45{,}000}{\text{Rs. } 20 - \text{Rs. } 13}$$

$$= 5{,}000 \text{ units}$$

3.6 EXPORT V/s LOCAL SALE DECISION

When the firm is catering to the needs of the local market and surplus capacity is still available, it may think of utilising the same to meet export orders at price lower than that prevailing in the local market.

This decision is made only when the local sale is earning a profit, i.e., where its fixed expenses have already been recovered by the local sales. In such cases, if the export price is more than the marginal cost, it is preferable to enter the export market.

Any reduction in the price prevailing in the local market to fulfil surplus capacity may have adverse effect on the normal local sales. Dumping in the export market at a lower price will not, however, have any such adverse effect on local sales.

Illustration

A firm gives the following data :

Selling price	Rs. 6 per unit	Fixed expenses	Rs. 15,000
Total cost	Rs. 5 per unit	Marginal cost	Rs. 4 per unit
Local sales	15,000 units	Capacity of the plant	20,000 units

Export order received for 3,000 units at Rs. 4.50 per unit. Advise whether to accept the export order or not.

Solution

$$\textit{Break-even point} = \frac{\text{Fixed expenses}}{\text{Contribution}}$$

$$= \frac{\text{Rs. } 15{,}000}{\text{Rs. } 6 - \text{Rs. } 4} = \frac{\text{Rs. } 15{,}000}{\text{Rs. } 2}$$

= 7,500 units

Since fixed expenses are recovered at this level of output, any price above the marginal cost will fetch additional profit. So the export selling price of Rs. 4.50 will fetch an additional profits of Rs. 1,500 as under :

3,000 units × (Rs. 4.50 – Rs. 4.00) = Rs. 1,500

Since the goods are sold in the export market, it will not have any adverse effect on the local selling price of Rs. 6 per unit.

Illustration

X Ltd., having an installed capacity of 1,00,000 units of a product is currently operating at 70% utilization. At current levels of input prices, the FOB unit costs (after taking credit for applicable export incentives) work out as follows:

Capacity Utilisation	*FOB Unit Costs*
Per cent	*Rs.*
70	97
80	92
90	87
100	82

The company has received three foreign offers from different sources as under:

Source A 5,000 units at Rs. 55 per unit FOB

Source B 10,000 units at Rs. 52 per unit FOB

Source C 10,000 units at Rs. 51 per unit FOB

Advise the company as to whether any or all export orders should be accepted or not.

Solution

X Limited

Statement showing Differential Cost at Different Capacity Utilisation Levels

Installed capacity 1,00,000 Units

Capacity utilisation	*Production at different levels differential of capacity utilisation*	*FOB unit costs*	*Total costs*	*Differential costs*	*Per unit costs*
Percent	*Units*	*Rs.*	*Rs.*	*Rs.*	*Rs.*
70	70,000	97	67,90,000	—	—
80	80,000	92	73,60,000	5,70,000	57
90	90,000	87	78,30,000	4,70,000	47
100	1,00,000	82	82,00,000	3,70,000	37

Statement showing Gain or Loss on Accepting the Various Export Orders

Export Order (Source)	*Export Order (Unit)*	*Capacity Utilisation Per cent*	*Differential Costs*		*FOB Price per Unit*	*Sales Revenue from the Export*	*Gain/ (Loss)*
			Per Unit	*Total*			
			Rs.	*Rs.*	*Rs.*	*Rs.*	*Rs.*
A	5,000 (10,000)	75%	5,000 Uts. @ 57	2,85,000	55	2,75,000	
B	10,000	85%	5,000 Uts. @ 57 5,000 Uts. @ 47	5,20,000	52	5,20,000	Nil
C	10,000	95%	5,000 Uts. @ 47 5,000 Uts. @ 37	4,20,000	51	5,10,000	90,000
Total	25,000	95%		12,25,000		13,05,000	80,000

It is obvious from the above statement that the company will gain only when all the three export orders are accepted. If the company accepts exports only for one or two of the three sources, it will loose. Therefore, the company should accept all the three exports orders.

3.7 EXPAND OR CONTRACT DECISION

Whenever a decision is to be taken as to whether the capacity is to be expanded or not, consideration should be given to the following points:

(a) Additional fixed expenses to be incurred.

(b) Possible decrease in selling price due to increase in production.

(c) Whether the demand is sufficient to absorb the increased production.

Based on these considerations, the cost schedule will be worked out. While deciding about the contraction of business, the saving in fixed expenses and the marginal contribution lost will have to be taken into account. If a branch office is to be closed down, and if the branch is giving a marginal contribution sufficient to cover fixed expenses the contraction may lead to a loss as under :

Example

Branch B : Sales		Rs. 20,000
	P/V ratio	20%
	Marginal contribution	Rs. 4,000
	Fixed expenses of the branch	Rs. 3,000

The branch is giving an extra contribution of Rs. 1,000. If it is closed, the fixed expenses saving is Rs. 3,000 whereas the contribution lost is Rs. 4,000. Hence it is not advisable to contract the business by closing down the branch.

Illustration

Nice and Warm Ltd., manufactures and markets hot plates. During the first five years of operation, the company had experienced a gradual increase in sales volume, and the current annual growth in sales of 5% is expected to continue into the foreseeable future. The plant is now producing at its full capacity of one lakh hot plates.

At the monthly Management Advisory Committee meeting, amongst other things, the plan of action for next year was discussed.

Managing Director proposed two alternatives. First, operations could be continued at full capacity and with the existing facilities an output of one lakh hot plates at a selling price of Rs. 100 per unit could be maintained. Secondly, production and sales could be increased by 5% to take advantage of the rate of expansion in demand for the product. But this could increase cost, as to achieve the output, the company will have to resort to weekend and overtime workings. However, a policy of steady growth was preferable to maintaining status quo.

In view of the company's competitors having a substantial share of the market, the Works Director was of the view that it was not enough for the company to maintain merely the present share of the total market. A larger share of the total market should be obtained. For that, the company should increase the production by 10% through a modest expansion of plant capacity. In order to sell the output of 1,10,000 units, the selling price could be reduced to Rs. 95 per unit.

Thinking on the same lines, the Marketing Director put forth a more radical proposal. The strategy should be to seize the competitive leadership in the market with regard to both price and volume. With this end in view, he suggested that the company should straight away embark on an expensive modernisation programme which will initially increase volume by 20%. The entire output of 1,20,000 hot plates could be easily sold at a price of Rs. 90 per unit.

At this juncture Managing Director expressed concern about the probable behaviour of the company's competitors. They might also expand in order to produce more and sell at lowest prices. Suppose this happened, he wanted also the financial effects of the proposals of the Works Director and the Marketing Director, if in those proposals, the increase in sales were to be only half of that predicted.

As the Cost Accountant of the company you are required to critically evaluate the six alternatives, along with your recommendations and circulate the same to the Directors.

In this connection you have gathered the following details.,

(1) If next year's production was maintained at the current year's level variable costs would remain unchanged at Rs. 30 lakhs.

(2) The weekend and overtime working would increase with the variable and fixed costs. Variable cost would rise to Rs. 55 per unit while fixed costs would increase to Rs.30,25,000.

(3) In the proposal of the Works Director, the ratio of variable costs to sales would continue to be 50% and fixed costs would rise to Rs. 32,25,000.

(4) In the proposal of the Marketing Director, as a result of increased production efficiency and some savings from purchase of materials, it is estimated that the ratio of variable cost to sales would decrease to 48% and the fixed costs would increase by Rs. 5,16,000.

Your answer should contain:

(a) A tabular statement of comparative figures pertaining to Total Turnover, Total Contribution, Percentage of Profit to Sales and Break-Even units as regards to each of the six proposals.

(b) Comment on the relative risks involved.

(c) Consideration of the short-term and long-term implications of the Managing Director's proposals.

(d) Comments on the price elasticity of demand for the company's product and your suggestions on the pricing policy and cost structure.

(e) Comments on financial implications of the expansion schemes.

(a) Tabular Statement of Comparative Figures Pertaining to Total Turnover, Total Contribution, Percentage of Profit to Sales and Break-even Units etc., as regards to each of the Six Proposals.

	Proposals					
	Managing Director's 1st Proposal	*Managing Director's 2nd Proposal*	*Works Director's 1st Proposal*	*Works Director's 2nd Proposal (1/2 of expected increase)*	*Marketing Director's 1st Proposal*	*Marketing Director's 2nd Proposal (1/2 of expected increase)*
	(1)	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***
Units sold	1,00,000	1,05,000	1,10,000	1,05,000	1,20,000	1,10,000
Unit selling price (Rs.)	100	100	95	95	90	90
Total turnover (Rs. in lakhs)	100.00	105.00	104.50	99.75	108.00	99.00
Unit contribution (Rs.)	50	45	47.5	47.5	46.80	46.80
Total contribution (Rs. in lakhs)	50	47.25	52.25	49.875	56.16	51.48
Fixed cost (Rs. in lakhs)	30	30.25	32.25	32.25	35.16	35.16
Profit (Rs. in lakhs)	20	17.00	20.00	17.625	21	16.32
Percentage of profit to sales	20%	16.19%	19.14%	17.67%	19.44%	16.48%
Break-even units	60,000	67,222	67,895	67,895	75,128	75,128
Margin of safety in units	40,000	37,778	42,105	37,105	44,872	34,872

Solution

(a) For this part refer to page 3.34.

(b) At the present full capacity level, it is enough to sell 60,000 units to break even. Other proposals raise the break-even point further. In an uncertain market, if in the proposals of Works Director and the Marketing Director, only half the increase is achieved, the margin of safety will be lower than the present 40,000 units. Profit as a percentage of sales is also lower than existing, in all the proposals. All this is a disquieting feature as the risk involved is greater in all the other proposals.

(c) The company has already reached its full capacity. As a short term measure, the Managing Director's first proposal seems to be all right. From long-term point of view, neither of the proposals can be considered to be satisfactory. Both the proposals of the Managing Director do not provide a lasting solution. Though the second proposal maintains the market share, it results in less profit, both in quantum and percentage. As the capacity has already been reached there is an urgent necessity for the Managing Director to address himself to long range objectives and plans keeping in view the expansion in demand for the company's product.

(d) It seems that both the Works Director and the Marketing Director have very elementary notions on price. They think that if the volume increases in order to sell the increased volume, price has to be lowered. No serious study seems to have been made on the price elasticity of demand for the company's product. On the other hand, we have been told that there is a steady 5% annual growth in demand, which means that the prices need not be reduced, only more market share has to be obtained. For incremental production, differential pricing in certain special markets has to be resorted to; if this is not possible, the increased production can be sold under a different brand name with a different price (A static cost structure, more or less, has been assumed). To beat competition, a better product has to be put in the market and cost reduction offered through value analysis, etc.

(e) The expansion scheme envisaged have to be properly tested for profitability by feasibility study reports, etc. Source of financing the expansion has to be determined. The financial implications of share issue or borrowed funds have to be gone through. Long range objectives have to be defined and plans drawn accordingly to achieve them.

3.8 PRODUCT MIX DECISION

Many times the management has to take a decision whether to produce one product or another instead. Generally decision is made on the basis of *contribution of each product*. Other things *being the same the product which yields the highest contribution is best one to produce*. But, if there is shortage or limited supply of certain other resources which may act as a key factor like for example, the machine hours, then the contribution is linked with such a key factor for taking a decision. For example, in an undertaking the availability of machine capacity is limited and the machine hours required for one unit of the two products are

different. In such cases the contribution is to be linked with the machine hour and the product which yields the highest contribution per machine hour is to be preferred for taking decision.

Illustration

There are two products A and B. The selling prices, variable costs and machine hours required per unit are:

	A	B
Selling price (Rs.)	2.00	2.50
Variable cost (Rs.)	1.00	1.50
Machine hours	2	1

Find the more profitable product when plant capacity is limited.

Solution

Selling price (Rs.)	2.00	2.50
Less : Variable cost (Rs.)	1.00	1.50
Contribution (Rs.)	1.00	1.00
Machine hours required	2	1
Contribution per machine hours (Rs.)	0.50	1.00

From the above it is evident that the contribution of product A & B in absolute terms is the same. However, when we link this contribution with the machine hour which is a key factor, the product 'B' gives more profit. As such, product 'B' is to be given preference over product 'A'.

Illustration

A firm manufactures 5 products using the same raw materials which is in short supply. By examining the following information, show which product is to be chosen so that the profit can be the maximum.

	Products				
	A	B	C	D	E
Sales (units)	1,500	2,500	1,600	2,000	2,200
Production (units)	2,000	3,000	1,500	2,000	2,000
Possible sales	1,500	2,500	1,500	2,000	2,000
Selling price per unit	4.00	3.50	1.50	1.00	3.00
Marginal cost per unit	3.00	2.00	1.25	0.75	2.50
Contribution per unit	1.00	1.50	0.25	0.25	0.50
Raw material required (kgs.)	2	8	3	5	2
Contribution against 1 kg. of raw material	0.50	0.19	0.083	0.05	0.25

Solution

When raw material is in short supply, the order in which production is to be undertaken is A, E, B, C, D based on contribution per unit of the key factor.

Let us suppose that 5,000 kgs. of raw material is available. Our production pattern will be as under:

Product	*Sales units*	*Material per unit kgs.*	*Total material kgs.*	*Contribution per unit Rs.*	*Total contribution Rs.*
A	1,500	2	3,000	1.00	1,500
E	1,000	2	2,000	0.50	500
			5,000		2,000

Although the unit contribution of product B is the largest, when the key factor is raw material supply, it ranks third in priority for manufacture, because it consumes more raw material.

Illustration

(a) Alcos Ltd., manufactures and sells four types of products under the brand names A, B, C and D. The sales mix in value comprises 33-1/3%, 41-2/3%, 16-2/3% and 8-1/3% of A, B, C and D respectively. The total budgeted sales (10%) are Rs. 60,000 per month.

Operating costs are :

Variable costs:

A 60% of selling price

B 68% of selling price

C 80% of selling price

D 40% of selling price

Fixed costs – Rs. 14,700 per month.

Calculate the break-even point for the products on an overall basis.

(b) It has been proposed to change the sales mix as follows, the total sales per month remaining Rs. 60,000.

A 25%

B 40%

C 30%

D 5%

Assuming that the proposal is implemented.

Calculate the new break-even point.

Solution

(a)

	Products				
	A	B	C	D	Total
Sales mix	33%	41%	I6%	8%	100%
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales	20,000	25,000	10,000	5,000	60,000
Variable cost	12,000	17,000	8,000	2,000	39,000
Contribution	8,000	8,000	2,000	3,000	21,000

P/V ratio: $\frac{\text{Contribution}}{\text{Sales}} \times 100 = \frac{\text{Rs. } 21{,}000}{\text{Rs. } 60{,}000} \times 100 = 35\%$

Break-even point (Sales value): $\frac{\text{Fixed costs}}{\text{P / V ratio}} = \frac{\text{Rs. } 14{,}700}{0.35} = \text{Rs. } 42{,}000$

(b) The revised contribution after change in sales mix

	Products				
	A	*B*	*C*	*D*	Total
Sales mix	25%	40%	30%	*5%*	100%
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales	15,000	24,000	18,000	3,000	60,000
Variable costs	9,000	16,320	14,400	1,200	40,920
Contribution					19,080

P/V ratio = $\frac{\text{Rs. } 19{,}080}{\text{Rs. } 60{,}000} \times 100 = 31.8\%$

Break-even point (Sales value) = $\frac{\text{Rs. } 14{,}700}{0.318} = \text{Rs. } 46{,}226.$

Illustration

A firm's operations are at present performed by hand. It has a proposal to install a new machine which can produce at a faster rate. Following information is available. Advise the management about the profitability of mechanisation.

	Hand	*Machine*
Production in units per hour	1	2
Marginal cost per unit (Rs.)	18	16
Additional fixed cost per unit (Rs.)	—	3
Total cost per unit (Rs.)	18	19
Selling price per unit (Rs.)	24	24

Solution

Let us analyse the figures as under:

	Hand	*Machine*
	Rs.	Rs.
Selling price per unit	24	24
Less: Marginal cost per unit (including additional fixed cost)	18	19
Contribution per unit	6	5
Contribution per hour	6	10

If there is a great demand for the products, it is advisable to mechanise because the gross margin per hour is more than that under hand operation.

If however, there is idle capacity and there is an under- absorption of fixed overheads to the extent of Rs. 3 per unit the total cost will be Rs. (19 + 3) = Rs. 22 leaving a contribution of Rs. 2 per unit. The contribution per hour will, therefore, be Rs. 4 which is less than that of obtaining under hand operation. Hence mechanisation will not be advisable under these circumstances.

Illustration

An engineering company is engaged in producing four products through operations at welding and pressing departments. Products W_1 and W_2 are produced by welders in the welding department whereas products P_1 and P_2 are produced by press-operators in the pressing department. Due to specific skill requirements, the welders and press-operators can only work in their own department.

The following relevant data are available in respect of the products:

	Products			
	W_1	W_2	P_1	P_2
Hours required per unit	4	4	5	2
Selling price per unit (Rs.)	48	50	77	69

Direct material cost per unit (Rs.)	18	22	32	44
Direct labour hourly rate (Rs.)	4	4	4	4
Variable overhead rate per unit (Rs.)	2	2	3	3

The company incurs Rs. 50,000 per annum towards fixed costs. The maximum available hours are 20,000 and 16,000 for welding and pressing departments respectively.

The demands keep on fluctuating but the minimum demands which are to be met as per management's decision are 2,000 units of W_I, 2,500 units of W_2, 1,800 units of P_1 and 2,200 units of P_2.

The production manager suggests that the welders and press- operators can be trained to perform both welding and pressing jobs so that excess demand of any of the products can be met. This decision is going to increase the burden of fixed costs by Rs. 5,000 per annum.

Prepare the profitability statement for optimum product-mix and recommend with reasons and appropriate workings whether it is advisable to train the welders and press-operators as suggested by the production manager.

Solution

Optimum Product Mix Before Training

Department	*Welding*		*Pressing*	
Maximum Hours	*20,000 hours*		*16,000 hours*	
Product	*W_1*	*W_2*	*P_1*	*P_2*
Selling price per unit (Rs.)	48	50	77	69
Less: Variable cost				
Material (Rs.)	18	22	32	44
Labour (Rs.)	16	16	20	8
Variable overhead (Rs.)	2	2	3	3
Total variable cost (Rs.)	36	40	55	55
Contribution per unit : (A)	12	10	22	14
Labour hours per unit : (B)	4	4	5	2
Contribution per hour (Rs.) (A) (B)	3	2.5	4.4	7
Ranking	*I*	*II*	*II*	*I*
Minimum production (units)	2,000	2,500	1,800	2,200
Labour hours needed	8,000	10,000	9,000	4,400
Labour hours used for each department	8,000 + 10,000 = 18,000		9,000 + 4,400= 13,400	

Balance hours available	20,000 – 18,000 = 2,000	16,000 – 13,400 = 2,600
Product to be produced	W_I	P_2
Units to be produced	2,000/4 = 500	2,600/2 = 1,300
	W_1 W_2	P_1 P_2
Hence, product-mix (units)	2,000 + 500 2,500 = 2,500	1,800 2,200 +1,300 = 3,500

Profitability Statement before Training

Product	*Product-mix units*	*Hours*		*Contribution*	
		Per unit	*Total*	*Per hour*	*Total*
			Rs.	*Rs.*	
W_1	2,500	4	10,000	3.00	30,000
W_2	2,500	4	10,000	2.50	25,000
			20,000		55,000
P_1	1,800	5	9,000	4.40	39,600
P_2	3,500	2	7,000	7.00	49,000
			16,000		88,600
	Total		36,000		1,43,600
			Less: Fixed costs		50,000
			Net profit		93,600

Optimum Product-Mix After Training

After training, the capacity will be taken as a whole at 36,000 labour hours because of interchangeability of available labour force. The ranking will be done on the basis of contribution per hour among all the four products, since a workman is trained to work in any of the departments.

Production	W_1	W_2	P_1	P_2
Maximum hours		36,000 hours as a whole		
Hours needed for minimum production	8,000	10,000	9,000	4,400
		(Total hours = 31,400 hours)		
Balance hours	(36,000 – 31,400 hours = 4,600 hours)			
Product priority (Ranking)	III	IV	II	I
Product in balance hours P_2 (I rank): 4,600 ÷ 2 = 2,300 units				
Product-mix (units)	2,000	2,500	1,800	2,200 + 2,300 = 4,500

Profitability Statement After Training

Product	*Product-mix units*	*Hours*			*Contribution*	
		Per unit	*Total*		*Per hour*	*Amount*
		Rs.	*Rs.*		*Rs.*	
W_1	2,000	4	8,000		3.00	24,000
W_2	2,500	4	10,000		2.50	25,000
P_1	1,800	5	9,000		4.40	39,600
P_2	4,500	2	9,000		7.00	63,000
			36,000			1,51,600
				Less: Fixed costs		55,000
				Net profit		96,600

Recommendation:

Since the net profit after training will be more by Rs. 3,000 (Rs. 96,600 – Rs. 93,600), it is advisable to train the welders and press operators as suggested by the production manager.

Illustration

Veejay Ltd. makes and sell two products, Vee and Jay. The budgeted selling price of Vee is Rs. 1,800 and that of Jay is Rs. 2,160. Variable costs associated with producing and selling the Vee are Rs. 900 and with Jay Rs. 1,800. Annual fixed production and selling costs of Veejay Ltd. are Rs. 88,000.

The company has two production/sales option. The Vee and Jay can be sold either in the ratio of two Vees to three Jays or in the ratio of one Vee to two Jays.

What will be the optimal mix and why ?

Solution

Selection of best optimal mix

	Products	
	Vee	*Jay*
	Rs.	Rs.
Budgeted selling price p.u.	1,800	2,160
Less : Variable cost p.u.	900	1,800
Contribution p.u.	900	360

(I) *Production/Sales option : (2 units of Vee and 3 units of Jays)*

Total contribution under 1st option

= (2 units × Rs. 900 + 3 units × Rs. 360)

= Rs. 1,800 + Rs. 1,080 = Rs. 2,880

Break-even point $= \frac{\text{Annual fixed production \& selling costs}}{\text{Total contribution under Ist option}}$

$= \frac{\text{Rs. } 88{,}000}{\text{Rs. } 2{,}880}$ = 30.56 (sets of 5 units each)

	Products		
	Vee	*Jay*	*Total*
Break-even point (units)	30.56 × 2 units	30.56 × 3 units	
	= 61.12 units	= 91.68 units	
	= 61 (units approx.)	= 92 (units approx.)	
Break–even sales (Rs)	= 1,09,800	= 1,98,720	3,08520
	(61 units × Rs. 1,800)	(92 units × Rs. 2,160)	

(II) *Production/Sales option : (1 unit of Vee and 2 units of Jays)*

Total contribution under IInd option

= (1 unit × Rs. 900 + 2 units × Rs. 360)

= Rs. 900 + Rs. 720 = Rs. 1,620

Break–even point = $\frac{\text{Annual fixed production \& selling costs}}{\text{Total contribution under Ist option}}$

$= \frac{\text{Rs. } 88{,}000}{\text{Rs. } 2{,}880}$ = 54.32 (sets of 3 units each)

	Products		
	Vee	*Jay*	*Total*
Break–even points (units)	54.32 × 1 unit	54.32 × 2 units	
	= 54 (units approx.)	= 109 (units approx.)	
Break–even sales (Rs.)	= 97,200	= 2,35,440	3,32,640
	(54 units × Rs. 1,800)	*(109 units × Rs. 2,160)*	

Note:

The given amount of annual fixed production and selling cost is such that it fails to determine the exact figure of break–even point under two given sales options. The approximations made

in the above solutions under option I, at break–even lelvel over recovers Rs. 20; whereas under option II of the solution there is an under recovery of fixed cost to the extent of Rs. 160.

Decision & reasoning :

Option I is preferred over option II, as it results in a lower level of sales to reach break–even (because of higher average contribution per unit sold). The average contribution per unit (under option I) is Rs. 576 (Rs. 2,880/5 units) and (under option II) it is Rs. 540 (Rs. 1,620/3 units). Option I contains a higher percentage (40% as against 33 1/3%) of more profitable products.

Illustration

ZED Ltd. manufactures two products P and Q and sells them at Rs. 215 and Rs. 320 per unit respectively. The variable costs per unit are as under.

	Product-P	*Product-Q*
	Rs.	*Rs.*
Raw materials :		
Material-X	22.00	28.00
Material-Y	8.00	32.00
Direct wages (Rs.6 per labour hour) :		
Department-A	36.00	54.00
Department-B	18.00	36.00
Department-C	54.00	—
Department-D	—	72.00
Variable overheads	23.00	14.30

The company procures raw materials against import licence. The company operates at single shift a day of 8 hours for 300 days in a year. The number of workmen engaged are 30, 16, 18 and 24 in departments A, B, C and D respectively. Neither the workers are subject to transfer from one department to another nor any new recruitment is possible at present. Fixed costs are Rs. 12,000 per month.

You are required to find out the following :

(a) The product-mix to yield maximum profit

(b) The most profitable product if only one product is to be manufactured. Whether the answer will differ if licence to import raw materials is released only for Rs. 1,80,000.

Solution

Working Notes :

1. Computation of total labour hours available

Departments	*No. of workmen*	*Days*	*Hrs./day*	*Total hours*
(a)	*(b)*	*(c)*	*(d)*	*(e) = (b) × (c) × (d)*
A	30	300	8	72,000
B	16	300	8	38,400
C	18	300	8	43,200
D	24	300	8	57,600

2. Computation of hours required per unit of each product

Departments	*Product P*			*Product Q*		
	Wages (Rs.)	*Wages/hr. (Rs.)*	*Hrs.*	*Wages (Rs.)*	*Wage/hr. (Rs.)*	*Hrs*
	(a)	*(b)*	*(c) = (a)/(b)*	*(d)*	*(e)*	*(f) = (d)/(e)*
A	36	6	6	54	6	9
B	18	6	3	36	6	6
C	54	6	9	–	–	–
D	–	–	–	72	6	12
Total hours per unit :			18			27

3. Statement showing maximum output permissble

Departments	*Hours available*	*Product P*		*Product Q*	
		Hrs. required/ Unit	*Maximum output in Units*	*Hrs. required/ Unit*	*Maximum output in Units*
	(a)	*(b)*	*(c) = (a)/(b)*	*(d)*	*(e) = (a)/(d)*
A	72,000	6	12,000	9	8,000
B	38,400	3	12,800	6	6,400
C	43,200	9	4,800*	–	–
D	57,600	–		12	4,800*
Total hours p.u. :		18		27	

* This shows that either 4,800 units of product P or Q can be obtained by utilising the available hours in the four departments.

4. Productwise contribution per hour

	Product P	*Product Q*
	Rs.	*Rs.*
Selling price p.u. (A)	215	320
Total raw material cost p.u.		
(Rs. 22 + Rs. 8)		
(Rs. 28 + Rs. 32)	30	60
Total wages per unit		
(Rs. 36 + Rs. 18 + Rs. 54)		
Rs. 54 + Rs. 36 + Rs. 72) 108	162	
Variable overheads p.u.	23	14.30
Total variable cost p.u. (B)	161	236.30
Contribution p.u. [(A) – (B)] 54	83.70	
Labour hours p.u.	18	27
Contribution per labour hour	3	3.10
	(Rs. 54/18 hrs.)	(Rs. 83.70/27 hrs.)

(a) Though the contribution per labour hour of Product Q is better but there is a constraint viz., the numbers of workers in each department can neither be interchanged nor newly recurited, hence due to this following alternatives would arise which may help in deciding about the product mix to yield maximum profit.

Alternative I : Producing 4,800 units of Product Q and utilising the remaining available hours of labour for making units of Product P.

Alternative II : Producing 4,800 units of Product P and utilising the remaining available hours of labour for making units of Product Q.

Statement of Product mix under alternative I

Departments	*Available hours*	*Hours required for 4,800 units of Q*	*Remaining hours*	*Hrs./Unit of Product P*	*Units of Product*
	(a)	*(b)*	*(c) = (a)–(b)*	*(d)*	*(e) = (c)/(d)*
A	72,000	43,200	28,800	6	4,800
B	38,400	28,800	9,600	3	3,200
C	43,200	–	43,200	9	4,800
D	57,600	57,600	Nil	–	–

The above table shows that out of the available hours under alternative I; 4,800 units of Product Q and 3,200 units of Product P can be made.

Statement of Product mix under alternative II

Departments	*Available hours*	*Hours required for 4,800 units of P*	*Remaining hours*	*Hrs./Unit of Product Q*	*Units of Product*
	(a)	*(b)*	*(c) = (a)–(b)*	*(d)*	*(e) = (c)/(d)*
A	72,000	28,800	43,200	9	4,800
B	38,400	14,400	24,000	6	4,000
C	43,200	43,200	–	–	–
D	57,600	–	57,600	12	4,800

The above table shows that out of the available hours under alternative II; 4,800 units of Product P and 4,000 units of Product Q can be made.

Profit Statement under above alternatives

Products	*First alternative*			*Second alternative*		
	Units	*Contribution p.u. (Rs.)*	*Amount Rs.*	*Units*	*Contribution p.u. (Rs.)*	*Amount Rs.*
P	3,200	54.00	1,72,800	4,800	54.00	2,59,200
Q	4,800	83.70	4,01,760	4,000	83.70	3,34,800
Total Contribution:			5,74,560			5,94,000
Less : Fixed cost p.a.			1,44,000			1,44,000
Profit			4,30,560			4,50,000

Second alternative is the most profitable product mix.

(b) Statement of most profitable product if only one product is to be manufactured

Products	*P*	*Q*
Contribution per unit (Rs.) : A	54.00	83.70
Maximum possible output (in units) : (B)	4,800	4,800
Total Contribution : (A) × (B)	2,59,200	4,01,760

Product Q is to be preferred

Statement of most profitable product if only one product is to be manufactured and licence to import the raw material is only for materials worth Rs. 1,80,000

Products	*P*	*Q*
Raw material required p.u. (Rs.)	30	60
Permissible output in units out of imported material of Rs. 1,80,000	6,000	3,000
Maximum output possible in the available hours	4,800	4,800
Output possible keeping in view the the availability of imported material and labour hours (Units)	4,800	3,000
Contribution per unit (Rs.)	54	83.70
Total Contribution (Rs.)	2,59,200	2,51,100
	(4,800 units × Rs. 54)	(3,000 units × Rs. 83.70)

Product P is to be preferred (i.e. answer differs) because of import licence restriction, which is only available for purchasing material worth only Rs. 1,80,000

Illustration

The relevant data of X Ltd. for its three products A, B and C are as under :

	A	*B*	*C*
Direct material (Rs./Unit)	260	300	250
Direct labour (Rs./Unit)	130	270	260
Variable overheads (Rs./Unit)	110	230	180
Selling price (Rs./Unit)	860	1,040	930
Machine Hours required (Per Unit)	12	6	3

The estimated fixed overheads at four different levels of 3,600; 6,000; 8,400; and 10,800 machine hours are Rs. 1,00,000; Rs. 1,50,000; Rs. 2,20,000 and Rs. 3,00,000 respectively. The maximum demand of A, B and C in a cost period are 500; 300 and 1,800 units respectively.

You are required to find out (i) the most profitable product-mix at each level and (ii) the level of activity where the profit would be maximum.

Solution

Working Note :

Ranking of three products A, B and C

Products	*A*	*B*	*C*
Selling price (p.u.) (Rs.)	860	1,040	930
Less : Variable cost p.u. (Rs.)	500	800	690
Contribution p.u. (R.s)	360	240	240
Machine hrs. required p.u.	12	6	3
Contribution per machine hour (Rs.)	30	40	80
	(Rs. 360/ 12. hrs)	*(Rs. 240/ 6 hrs.)*	*(Rs. 240/ 3 hrs.)*
Ranking	III	II	I
Maximum demand in units	500	300*	1,800

(i) **Statement of the most profitable product mix at each level of machine hours**

(*Refer to working note*)

	Machine hours			
Product (mix)	3,600	6,000	8,400	10,800
C	1,200 units *(3,600 hrs/ 3 hrs p.u.)*	1,800 units *(5,400 hrs/ 3 hrs p.u.)*	1,800 units	1,800 units
B	–	100 units *(600 hrs/ 6 hrs p.u.)*	300 units *(1800 hrs/ 6 hrs p.u.)*	300 units
A	–	–	100 units *(1,200 hrs/ 12 hrs p.u.)*	300 units *(3,600 hrs/ 12 hrs p.u.)*

(ii) **Statement of level of activity where the profit would be maximum**

[*Refer to the answer of part (i)*]

	Products								
Level of activity (Machine hours)	C units	Contribution* Rs.	B units	Contribution* Rs.	A units	Contribution* Rs.	Total Contribution (Rs.)	Fixed Cost (Rs.)	Net Profit (Rs.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7) = (2) + (4) + (6)	(8)	(7)–(8)
3,600	1,200	2,88,000 *(1200 × Rs. 240)*	–	–	–	–	2,88,000	1,00,000	1,88,000
6,000	1,800	4,32,000 *(1,800 × Rs. 240)*	100	24,000 *(100 × Rs. 240)*	–	–	4,56,000	1,50,000	3,06,000
8,400	1,800	4,32,000	300	72,000 *(300 × Rs. 240)*	100	36,000 *(100 × Rs. 360)*	5,40,000	2,20,000	3,20,000
10,800	1,800	4,32,000	300	72,000	300	1,08,000 *(300 × Rs. 360)*	6,12,000	3,00,000	3,12,000

Recommendation :

* At 8,400 machine hour level of capacity the company would earn maximum profit i.e. Rs. 3,20,000

* Refer to working note.

3.9 PRICE-MIX DECISION

When a firm can produce two or more products from the same production facilities and the demand of each product is affected by the change in their prices, the management may have to choose price mix which will give the maximum profit, particularly when the production capacity is limited.

In such a situation, the firm should compute all the possible combinations and select a price-mix which yields the maximum profitability.

Illustration

Sellaway Ltd. manufactures and markets 2 products A and B, the demand in the market of which fluctuates with the prices quoted. As a result of the deliberations of its recent Sales Conference the following data were agreed upon as a working basis:

Product	*A*			*B*		
Selling price per unit (Rs.)	32	30	28	22	20	18
Expected demand per month (Nos.)	900	1,000	1,500	1,600	2,000	3,000

8 labour hours are required to produce product A and 4 labour hours to produce product B and the maximum capacity of the factory is restricted to 20,000 labour hours per month.

The cost structure per unit of production is as under:

Product	*A*	*B*
	Rs.	Rs.
Direct material	4	3
Direct labour	6	5
Variable overheads	10	6
	20	14

Fixed overheads are Rs. 32,400 per quarter.

You are required to compute the possible combinations and arrive at a proper price mix for maximum profitability.

Solution.

Workings :

Product	*A*			*B*		
Selling price per unit (Rs.)	32	30	28	22	20	18
Expected demand per month (Nos.)	900	1,000	1,500	1,600	2,000	3,000
Total labour hours required	7,200	8,000	12,000	6,400	8,000	12,000
Variable cost per unit (Rs.)	20	20	20	14	14	14
Contribution per unit (Rs.)	12	10	8	8	6	4
Contribution per hour (Rs)	1.5	1.25	1	2	1.5	1
Total contribution (Rs.)	10,800	10,000	12,000	12,800	12,000	12,000

Possible combinations

Products		*Contribution*	*Labour Hrs.*
A	*B*	*Rs.*	*Reqd.*
32	22	23,600	13,600
32	20	22,800	15,200
32	18	22,800	19,200
30	22	22,800	14,400
30	20	22,000	16,000
30	18	22,000	20,000
28	22	24,800	18,400
28	20	24,000	20,000
28	18	24,000	24,000

Recommendations

The above computations show that the maximum contribution of Rs. 24,800 is possible at 18,400 labour hours. Therefore, profitable *price mix* is A Rs. 28 and B Rs. 22.

SUMMARY

- **Profit Statement Under Marginal Costing**

Statement of Profit	Rs.	Rs.
Revenue/Sales		xxx
Less: Variable cost of production		
Material	xx	
Labour	xx	
D. Expenses	xx	
Variable overhead	xx	
	xx	
Add: Opening Finished goods (at MC)	xx	
Less: Closing Finished goods (at MC)	xx	
Variable cost of goods sold	xxx	
Add: Variable Selling overhead	xx	
Variable cost of sales		xx
Contribution		xx
Less: All types of Fixed cost		xx
(Committed, Discretionary steps)		xx

- **Sales - Variable Cost** = Contribution = Fixed Cost + Profit
- **P/V ratio (or C/S ratio)** = Contribution Sales
  = Contribution per unit ÷ Selling price per unit
  = Change in Contribution ÷ Change in Sales
  = Profit Margin of Safety
- **Profit** = (Sales × P/V ratio) - Fixed Cost = P/V ratio × Margin of Safety sales(Rs.)
  = Contribution p.u. × Margin of safety (in units)
- **Break-even Point**
  a. Break Even point (in units) = Fixed Cost ÷ Contribution per unit
  b. Break Even Sales (in sales value) = Fixed Cost P/V ratio
  c. With semi - variable cost : apply the concept of apparent BEP
  d. Composite BEP i.e. more than one product with common fixed costs
     - ✓ Without limiting factor (non- attributable to a single product)

       BEP in units = Fixed cost ÷ Average contribution p.u.
       (when sales mix in units are given)
       BEP in Rs. = Fixed cost ÷ composite p\v ratio
       (when sales mix in rupee are given)
       where composite p\v ratio = $\sum$ [Sales Mix × P\V Ratio]
     - ✓ With limiting factor (attributable to a single product)

       Find contribution per limiting factor & give rank . Find total contribution from 1st rank product . Calculate the amount of fixed cost still to recover. Whether it can be recovered by 2nd rank product or not ?
- For Perishable product apply the same concept in case of opening stock with different variable cost.
- BEP in case of process costing is expressed in terms of total raw material input
- In capital budgeting , BEP is that sales volume where S discounted Cash in flow = S discounted Cash out flow.
- In case of perpetuity , the financing charge p.a.= CIF pa

  Potential BE : On the basis of sales out of current period production only.

  Multiple BE : Different BE due to change in sales price, variable costs & fixed costs for different production level.

  Cash BEP = Cash fixed cost ¸ contribution p.u. So do not consider the sunk cost.

  BEP for decision making purpose : Accept that proposal where BEP is lowest provided the profit can not be calculated.
- **PRICING DECISIONS UNDER SPECIAL CIRCUMSTANCES**

  If goods were sold in the normal circumstances under normal business conditions, the price would cover the total cost plus a margin of profit.

The problem of pricing can be summarised under three heads:

- ✓ Pricing in periods of recession,
- ✓ Differential selling prices, and
- ✓ Acceptance of an offer and submission of a tender.

Pricing in periods of recession : Sell its articles at a price *less than the total cost but above the marginal cost* for a limited period.

Differential selling prices: Which is above, the marginal cost but below the total cost is resorted to in order to absorb surplus capacity.

- **MAKE OR BUY DECISION**

  Very often management is faced with the problem as to whether a part should be manufactured or it should be purchased from outside market. Under such circumstances two factors are to be considered:

  - ✓ whether surplus capacity is available, and
  - ✓ the marginal cost.

- **SHUT DOWN OR CONTINUE DECISION**

  A firm to temporarily close down the factory due to trade recession with a view to reopening it in the future. In such cases, the decision should be based on the marginal cost analysis.

$$\text{Shut down point} = \frac{\text{Total fixed cost} - \text{Shut down costs}}{\text{Contribution per unit}}$$

- **EXPORT V/s LOCAL SALE DECISION**

  When the firm is catering to the needs of the local market and surplus capacity is still available, it may think of utilising the same to meet export orders at price lower than that prevailing in the local market.

- **PRICE-MIX DECISION**

  When a firm can produce two or more products from the same production facilities and the demand of each product is affected by the change in their prices, the management may have to choose price mix which will give the maximum profit, particularly when the production capacity is limited.

SELF-EXAMINATION QUESTIONS

1. Is there any relationship between selling price and cost?
2. What are the items which the selling price should cover in different circumstances?
3. What are the advantages of selling above marginal cost but below total cost?
4. Is it justifiable to sell at a price below marginal cost any time? Mention the circumstances in which it is justifiable?
5. What are the two ways in which differential selling price can be used?

6. State the considerations which a firm has to give in (a) acceptance of an offer and (b) submission of a tender.
7. State what type of cost analysis is useful in taking managerial decisions in the following cases:

   (a) Make or Buy
   (b) Retain or Replace a machine
   (c) Shut down or continue
   (d) Export sale *vs.* Local sale
   (e) Change *vs.* Status quo
   (f) Expand *vs.* Contract.

8. A company produces four articles. Machine time is valuable due to heavy power cut imposed by the Government. Show which product should be produced so that the profit earned is the highest by utilising the scarce machine time.
9. A firm is desirous of replacing hand operation by machine operation to produce at faster rate. State how cost information will be useful in taking a decision.
10. Summarise the various factors to be considered in making recommendations for managerial decisions.
11. Ramesh of Agra presently operates its plant at 80% of the normal capacity to manufacture a product only to meet the demand of Government of Tamil Nadu under a rate contract. He supplies the product for Rs. 4,00,000 and earns a profit margin of 20% on sales realisations. Direct cost per unit is constant.

The indirect costs as per his budget projections are:

Indirect costs	*20,000 units (80% capacity)*	*22,500 units (90% capacity)*	*25,000 units (100% capacity)*
	Rs.	*Rs.*	*Rs.*
Variable	80,000	90,000	1,00,000
Semi-variable	40,000	42,500	45,000
Fixed	80,000	80,000	80,000

He has received an export order for the product equal to 20% of its present operations.

Additional packing charges on this order will be Rs. 1,000.

Arrive at the price to be quoted for the export order to give him a profit margin of 10% on the export price.

12. The relevant data of X Ltd. for its three products A, B and C are as under;

Product	*A*	*B*	*C*
Direct material (Rs./Unit)	260	300	250
Direct labour (Rs./Unit)	130	270	260

Variable overheads (Rs./Unit)	110	230	180
Selling price (Rs./Unit)	860	1,040	930
Machine hours required (Per Unit)	12	6	3

The estimated fixed overheads at four different levels of 3,600; 6,000; 8,400 and 10,800 machine hours are Rs. 1,00,000; Rs. 1,50,000; Rs. 2,20,000 and Rs. 3,00,000 respectively. The maximum demand of A, B and C in a cost period are 500; 300 and 1,800 units respectively. You are required to find out (i) the most profitable product mix at each level and (ii) the level of activity where the profit would be maximum.

13. A company produces three products from an imported material. The Cost Structure per unit of the products are as under :

Product	*A*	*B*	*C*
	Rs.	Rs.	Rs.
Sales value	200	300	25
Direct material	50	80	60
Direct wages Rs. 6 per hour	60	120	108
Variable overheads	30	60	54

Out of Direct material 80% is Imported material @ Rs. 10 per kg.

Prepare a statement showing comparative profitability of the three products under the following scenarios :

(i) Imported material is in restricted supply.

(ii) Production capacity is limiting factor.

(iii) When maximum sales potential of products A and B are 1,000 units each and that of product 'C' is 500 units for specific requirements, availability of imported material is restricted to 10,000 kgs. per month, how the profit could be maximised?

14. A machine manufactures 10,000 units of a part at a total cost of Rs. 21 of which Rs. 18 is variable. This part is readily available in the market at Rs. 19 per unit.

If this part is puchased from the market then the machine can either be utilised to manufacture a component in same quantity contributing Rs. 2 per component or it can be hired out at Rs. 21,000.

Recommend which of the alternative is profitable?

ANSWERS TO SELF EXAMINATION QUESTIONS

1. In normal market conditions the answer is yes. But non-cost items also should be given due consideration.

2. In normal periods, the prices should cover total cost. During recession, it is justifiable to continue if the prices cover marginal cost. In extra ordinary circumstances selling at a price below marginal cost may be justified for a limited period.
3. (a) skilled employees can be retained.
   (b) market is not lost.
   (c) plants and machinery do not become obsolescent.
4. (a) If goods are perishable in nature.
   (b) If stocks are excessive.
   (c) To popularise a new product.
5. (a) Dumping in export market by supplying the same product at lower price.
   (b) Selling a new product at a price which is less than the total cost but greater than marginal cost.
6. Differential cost and differential revenue should be analysed.
7. (a) Use marginal cost analysis.
   (b) Use total differential cost analysis.
   (c) Consider additional fixed expenses incurred in shut down.
   (d) Utilisation of surplus capacity is the main consideration.
   (e) A detailed profitability analysis should be made.
   (f) Contribution analysis and the fixed expenses saved should be compared.
8. The key factor in this problem is machine time. Express the contribution as percentage of the machine time. The product, which gives the highest contribution for key factor should be produced.
9. Make a total cost analysis and the interest on capital should be given due consideration.
10. (a) Marginal contribution.
    (b) Additional fixed expenses to be incurred.
    (c) Whether demand is inelastic and the price is stable.
    (d) Non-cost considerations should also be taken into account.
11. Export price to be quoted is Rs. 12.50 per unit.
12. (i) Most profitable product mix at each level is :

Different levels (M/c Hrs)	3,600	6,000	8,400	10,800
Product mix				
C	1,200	1,800	1,800	1,800

	units	units	units	units
B	—	100	300	300
	—	units	units	units
A	—	—	100	300
		units	units	

(ii) The level of activity where the profit would be maximum: At 8,400 machine hours, level of capacity, the company would earn maximum profit i.e., Rs. 3,20,000.

13. (i) A is profitable

(ii) A is profitable

(iii)

Product	A	B	C
No. of units	1,00,000	562	500
Maximum profit (Rs.)	60,000	22,480	14,000

14. 3rd alternative i.e. 10,000 units of the products are purchased from outside and the maximum time is hired out at Rs. 21,000.