

# Cost-Volume-Profit Relationships



Accountants and Managers are continually planning operations and making analyses to find best alternatives – whether to accept a certain business at a specified price or not, whether aggressively push the sales of one product or other, whether to exploit more intensively one or the other of the territories. Managers must understand the interrelationship of cost, volume, and profit for planning and decision making. In making their decision, managers need to understand relationship between selling price, sales volume, and costs. The method of studying the relationship among these factors is known as cost-volume- profit analysis (C-V-P analysis). They are also required to understand which costs should vary with changes in volume and which costs would stay the same. Without the knowledge of the behavior of cost, that have already discussed in detail in unit 2 of this book, they can not accurately determine the effect of price, volume or cost changes on the company's operating profit. In this unit, we discuss C-V-P analysis that provides accountants and managers with a comprehensive overview of the effects on revenue and costs of all kinds of short run financial changes.

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## Lesson-1: Basics of Cost-Volume-Profit Relationships

After completing this lesson, you are expected to be able to:

- Know the meaning objectives and assumptions of cost-volume profit analysis.
- Know the importance of cost-volume profit analysis.
- Know what contribution margin is and how it is calculated.
- Solve the problems relating to cost-volume profit.

### Introduction

In simple words, cost-volume-profit (hereafter C-V-P) analysis is the most fundamental tool because it provides straightforward ways to study the effects of changes in costs and volume on a company's profits. C-V-P analysis is important in profit planning. In C-V-P analysis executives and accountants recognize that there are many interacting variables that affect an organization's profits-such things as the sales price of a product, the variable costs per unit, and the volume of production and sales. C-V-P analysis evaluates the relationships among these interacting variables and the effect that changes in these variables have on an organization's profits. As the term itself suggests, C-V-P analysis is an analytical technique which examines costs and revenue behavioral patterns and their relationships with profit. The analysis separates costs into fixed and variable components and determines the levels of activity where costs and revenues are in equilibrium. We define C-V-P analysis as a mature model in such management decisions as setting selling prices, determining cost, determining the best product mix, and making maximum use of production facilities. The usual starting point in such an analysis is the determination of the company's break – even point. Thus, break – even analysis forms often a key component of the total system of C-V-P analysis which gives the executives and accountants many insights in profit planning.

*C-V-P analysis is an analytical technique which examines costs and revenue behavioral patterns and their relationships with profit.*

### Basic Components:/Assumptions of C-V-P Analysis

The technique of C-V-P analysis rests on a set of assumptions. These assumptions may be identified as the fundamental base of such analysis. The importance of identifying and criticising the underlying assumptions of C-V-P analysis rests on the practical application of C-V-P analysis. The assumptions underlying C-V-P analysis are mentioned below:

1. Total costs are separated into fixed and variable costs.
2. A firm's total revenue changes in direct proportion to changes in its unit sales volume. That is, the average sales price per unit of product is constant.
3. Fixed costs remain fixed over a relevant range of activity.
4. Variable cost per unit is also constant. Therefore, total variable costs are directly proportional to volume. There is either no

inflation or, if it can be forecasted, it is incorporated into the C-V-P analysis. This eliminates the possibility of cost changes.

5. Selling prices are constant per unit.
6. Prices of factors of production e.g. material price, wage rate etc. are constant.
7. There will be no changes in firm's efficiency or productivity.
8. Changes in activity are the only factors that affect costs.
9. All units produced are sold. Inventories are significant.
10. In a multi-product firm, the sales mix will remain constant. If this assumption is not made, no weighted average contribution margin could be computed for the company.
11. There will not be any significant change in the inventory level at the beginning and at the end of the year.
12. The firm is assumed to make analysis under short run.
13. The analysis will be effective for a limited range of operation over which the firm was operating in the past and expected to operate in future. It is known as relevant range. Relevant range is the levels of activities within which a particular cost behavior does not change. [C-V-P analysis under uncertainty is treated separately.]
14. Uncertainty and risks do not exist.

It is frequently found that students are quite happy to apply C-V-P analysis principles in theoretical setting but may be unaware of these assumptions and how restrictive they really are. When these assumptions are not valid, the results of C-V-P analysis may be inaccurate. These assumptions are also termed as limitations of C-V-P analysis.

### **Objectives of C-V-P analysis**

Accountants and executives are uncertain about some of the variables used in C-V-P analysis, though this analysis can be used to answer several types of questions and can be helpful in decision making. The basic objective of C-V-P analysis is to establish what will happen to the financial position if the output level fluctuates. This analysis will help the management to:

1. Make reasonably accurate forecast of future profits;
2. Assess the degree of risk involved in output fluctuation. If the present activity level of the organization is very near to no profit no loss situation or the proportion of fixed cost in the cost structure is very high, the degree of risk will be high in as much as a slight fall in output will lead to a significant fall in profit. This is also known as operating risk.

*The basic objective of C-V-P analysis is to establish what will happen to the financial position if the output level fluctuates.*

3. Take different decisions that are important for the operations of business. It includes pricing decisions, make or buy decision, shut down decision and like.
4. Prepare budget for future activities. **(jayanta ghosh; p.9.15)**

### **Contribution Margin (CM)**

One of the key relationships in C-V-P analysis is the *contribution margin (CM)*. Contribution margin is the excess of revenue over the variable costs of generating that revenue.

$$\text{Contribution Margin} = \text{Sales} - \text{Variable Costs of Sales}$$

This amount indicates the taka figure available to 'contribute' to the coverage of all fixed expenses, both manufacturing and non-manufacturing. The sequence here is that, contribution margin is used first to cover the fixed expenses, and then whatever remains goes toward profit. If the contribution margin is not sufficient to cover the fixed, then a loss occurs for the period.

*Contribution margin is used first to cover the fixed expenses, and then whatever remains goes toward profit.*

We will use following relevant data of the Appollo Company to understand various important issues relating to C-V-P analysis.

Unit selling price :	Tk.50
Unit variable costs :	Tk.30
Total monthly fixed costs :	Tk.20,000
Units sold :	1000 units

Therefore, Contribution Margin is : **(Sales – Variable Costs of Sales)**  
: (1000 units × Tk.50) – (1000 units × Tk.30) = Tk.20,000

This contribution margin is then available to cover fixed costs and to contribute income for the Appollo Company. In other words, this indicates how much revenue is available to cover all period expenses and potentially to provide net income.

Viewers differ as to the best way to express contribution margin (CM). Some executives and accountants favor a per unit basis. We can determine the amount that each unit contributes – the contribution margin per unit (CMPU) in two different ways. In the first way we merely subtract the variable cost per unit from the sales price per unit:

**Contribution Margin Per Unit (CMPU) : Sales price per unit – Variable costs per unit**

At the Appollo Company, the CMPU is Tk. 20, computed as follows:

$$\text{CMPU} = \text{Tk.50} - \text{Tk.30} = \text{Tk.20}$$

The contribution margin per unit indicates that for every unit sold, Appollo company will have Tk.20 to cover fixed costs and contribute to income. In other words, this means that each time a unit is sold, it provides, or contributes, the difference between the sales price and the

unit variable costs toward covering the fixed costs needed to produce and sell all the units.

Since fixed costs are Tk.20,000, Appollo must sell 1000 units (Tk.20,000 / Tk.20) before there is any income. Above the sales volume of 1000 units, every unit sell will contribute Tk.20 to income.

The second way to calculate CMPU is to divide the total contribution margin by the number of units sold. :

$$\text{Contribution Margin Per Unit (CMPU)} : \frac{\text{Total Contribution margin}}{\text{Units sold}}$$

**Contribution Margin Ratio (CM Ratio):** In addition to being expressed on a per unit basis, sales revenue, variable costs, and contribution margin, some executives and accountants prefer to use another relationship in C-V-P analysis, which is known as contribution margin ratio. The contribution margin ratio (or contribution margin percentage) represents the portion of total sales that remains after the variable costs have been subtracted. This ratio is computed as follows:

$$\text{Contribution Margin Ratio} = \frac{\text{Total contribution margin}}{\text{Total sales Taka}} \times 100 \%$$

$$\text{Tk.20,000} \times 100 = 40\%$$

At the Appollo company, the CM ratio is :  $\frac{\text{Tk.20,000}}{(1000 \text{ units} \times \text{Tk.50})} \times 100 = 40\%$

The CM ratio of 40% means that 40 paisa of each sales taka (Tk.1 × 40%) is available to apply to cover fixed costs and to contribute to income. The CM ratio is extremely useful since it shows how the contribution margin will be affected by a change in total sales. This expression of contribution margin is important in determining the effect of changes in sales on income.

A second way to determine the CM ratio involves the contribution margin per unit and sales price per unit:

$$\text{Contribution Margin Ratio} : \frac{\text{CMPU}}{\text{Sales price per unit}} \times 100 \%$$

Finally, we can calculate the contribution margin ratio by subtracting the variable cost percentage from 100%, or the variable cost ratio from 1.

$$\text{Contribution Margin Ratio} : 100\% - \text{Variable Cost \% (VC\%)} \\ \text{or} \\ 1 - \text{Variable cost \% (VC\%)}$$

If the contribution margin ratio = 1 - VC%, then conversely the VC% = 1 - CM ratio.

Variable cost percentage (VC%) can be calculated in total sales form or per unit basis in the following ways:

$$\text{Variable cost percentage (VC\%)} = \frac{\text{Total variable costs of Sales}}{\text{Total sales taka}} \times 100\%$$

Or

$$\frac{\text{Variable cost per unit}}{\text{Sales price per unit}}$$

We have seen several ways to calculate contribution margin, contribution margin per unit and contribution margin ratio. It is not necessary to use all of these approaches in any one situation, it is likewise improbable that you can use a single approach in all situations. It is probably a good idea for you to understand each of the approaches, but the approach you will follow depends on the exact information you are provided with.

**Demonstration Problem**

**Problem no. 6.1.1**

The following information relates to three months' activities of a company which manufactures a single product.

Month	Production (Units)	Total Cost (Tk.)
June 2004	12,500	1,15,000
July	14,000	1,24,000
August	16,400	1,38,400

**Required:**

Examine the above figures and calculate:

- (a) Variable cost per unit, and
- (b) Total fixed cost

**Solution to the Demonstration Problem:**

(a) Calculation of variable cost per unit

Month	Units produced	Monthly changes in units	Total Cost Tk.	Monthly change in costs Tk.	Variable cost per unit Tk.
June	12,500	-	1,15,000	-	-
July	14,000	1,500	1,24,000	9000	6.00

(b) Calculation of Fixed cost

$$\text{Fixed Cost} = \text{Total Cost} - \text{Variable Cost}$$

For the month of July Tk.1,24,000-(14000 units × Tk.6.00) = Tk.40,000

For the month August Tk.1,38,400-(16,400 units × Tk.6.00) = Tk.40,000

**Problem 6.1.2**

The 2004 sales of Misu Company were Tk.76,40,000. Fixed Cost was Tk.24,51,000 and variable cost totaled Tk.47,36,800.

**Required:** (a) Computes the contribution margin

(b) Computes the contribution margin ratio.

**Solution to the Demonstration Problem:**

$$\begin{aligned} \text{(a) Contribution Margin} &= \text{Sales} - \text{Variable costs} \\ &= \text{Tk.}(76,40,000 - 47,36,800) \\ &= \text{Tk.}29,03,200 \end{aligned}$$

$$\begin{aligned} \text{(b) Contribution Margin ratio} &: \frac{\text{Total Contribution Margin}}{\text{Total Sales}} \times 100 \\ &= \frac{\text{Tk.}29,03,200}{76,40,000} \times 100 \\ &= 38\% \end{aligned}$$

**Problem 6.1.3**

XY Corporation estimates the following results for 2004:

Sales revenue (30,000 units @ Tk.8.00) Tk.2,40,000

**Cost of Goods Sold**

Finished Goods Inventory, beginning	Tk.9,000	
Cost of Goods manufactured	1,53,000	
Total Goods available for sale	1,62,000	
Finished goods inventory, ending	9,000	
Cost of Goods Sold		1,53,000
Gross Margin		87,000
Selling and Administrative expenses		
Variable	30,000	
Fixed	36,000	
Total Selling and administrative expenses		66,000
Operating income		Tk.21,000



There will be no beginning or ending work-in-process inventory. Cost of goods manufactured will consist of Tk.60,000 in direct materials, Tk.45,000 in direct labor, Tk.30,000 in variable overhead and Tk.18,000 in fixed overhead.

**Required:**

- (a) Calculate contribution margin.
- (b) Calculate contribution margin per unit.
- (c) Calculate contribution margin ratio.

**Solution to the Demonstration Problem:**

(a) Contribution margin = Sales - Variable Costs

Sales revenue		Tk.2,40,000
Variable Costs:		
Direct materials	Tk.60,000	
Direct Labor	45,000	
Variable overhead	30,000	
Variable selling and administrative expenses	30,000	1,65,000
Contribution margin		<u>Tk.75,000</u>

$$\begin{aligned} \text{(b) Contribution Margin per unit} &= \frac{\text{Total Contribution Margin}}{\text{Units Sold}} \\ &= \frac{\text{Tk.75,000}}{30,000 \text{ units}} = \text{Tk.2.50 per unit} \end{aligned}$$

$$\begin{aligned} \text{(c) Contribution Margin ratio} &= \frac{\text{Total Contribution Margin}}{\text{Total Sales}} \times 100 \\ &= \frac{\text{Tk.75,000}}{\text{Tk.2,40,000}} \times 100 \\ &= 31.25\% \end{aligned}$$

## **ASSIGNMENT MATERIALS**

### **A. Quizzes Questions:**

**1. Which of the following statements are true and which are false?**

- (i) Cost-volume-profit relationships that are not linear can be analyzed linearly by considering only the relevant range of volume.
- (ii) In Cost-volume-profit analysis, the volume index is always stated in takas.
- (iii) When cost-volume-profit analysis is used, the need for a cost accounting system is eliminated.
- (iv) A method used to estimate how changes in the total fixed costs, unit sales price, sales volume, unit variable costs, and sales mix will affect profit is known as C-V-P analysis.
- (v) The contribution margin is the difference between total revenue and fixed costs.
- (vi) The contribution margin increases in proportion to any increase in variable costs.
- (vii) If product A has a higher unit contribution margin than product B, then product A will always have a higher contribution margin ratio than product B.
- (viii) Item A sells for Tk.5. Fixed cost per unit is Tk.1, and variable costs per unit is Tk.3. The contribution margin ratio for item A is 20%.
- (ix) For a given increase in sales dollars, a high CM ratio will result in a greater increase in profits than will a low CM ratio.
- (x) Product B sells for Tk.12. Fixed costs per unit are Tk.4, and variable costs are Tk.7. The unit contribution margin is Tk.5.
- (xi) If a company's cost structure shifts toward greater fixed costs and lower variable costs, one would expect the company's CM ratio to fall.
- (xii) In cost-volume-profit analysis, the number of units sold is assumed to be equal to the number of units produced.

### **B. Multiple-choice:**

**2. Choose the best answer for each of the following questions by placing the identifying letter in the space provided to the left.**

- (i) In cost-volume-profit analysis, income tax expense:
  - (a) Is included among the monthly operating expenses as a variable cost.
  - (b) Is considered as a fixed cost of doing business.
  - (c) Is treated as a semi-variable cost that is partially dependent upon sales volume.
  - (d) Is generally ignored.

- (ii) Within the relevant range of production, average variable cost per unit tends to:
- (a) Fluctuate drastically.
  - (b) Vary inversely with the level of production.
  - (c) Vary directly and proportionately with the level of production
  - (d) Remain relatively constant.
- (iii) The contribution margin ratio is computed as:
- (a) Sales minus variable costs, divided by sales.
  - (b) Fixed costs plus variable costs, divided by sales.
  - (c) Sales minus fixed costs, divided by sales.
  - (d) Sales divided by variable costs.
- (iv) The contribution margin ratio is the ratio of the contribution margin to sales revenues. If sales revenue and variable costs both increase 10% and fixed costs do not change, what is the effect on the contribution margin ratio?
- (a) The contribution margin ratio will remain unchanged.
  - (b) The contribution margin ratio will increase.
  - (c) The contribution margin ratio will decrease.
  - (d) The change cannot be determined.
- (v) The present unit cost data for a product are : Selling price Tk.15, variable cost Tk.8. If selling price is reduced by 10% and variable cost is increased by 12.5%, which of the following is the amended contribution to sales ratio?
- (a) 0.50
  - (b) 0.666
  - (c) 0.333
  - (d) 0.25
- (vi) The contribution margin is also known as?
- (a) Marginal income
  - (b) Net income
  - (c) Net operating profit.
- (vii) If the fixed costs attendant to a product increase while variable costs and sales price remain constant, what will happen to contribution margin?
- (a) Increase
  - (b) Decrease
  - (c) Unchanged
- (viii) Using the following information calculate contribution margin ratio.
- |                              |                  |
|------------------------------|------------------|
| Sales Revenue (47,500 units) | Tk.1,18,750      |
| Variable costs               | <u>57,000</u>    |
| Contribution margin          | 61,750           |
| Fixed costs                  | <u>50,000</u>    |
| Operating income             | <u>Tk.11,750</u> |

- (a) 10%
  - (b) 42%
  - (c) 48%
  - (d) 52%
- (ix) From the above information what is the contribution margin per unit?
- (a) Tk.1.30
  - (b) Tk.1.20
  - (c) Tk.1.08
  - (d) Tk.0.52
- (x) Lester Company has a single product. The selling price is Tk.50 and the variable cost is Tk.30 per unit. The company's fixed expenses are Tk.2,00,000 per month. What is the company's unit contribution margin?
- (a) Tk.50
  - (b) Tk.30
  - (c) Tk.20
  - (d) Tk.80
- (xi) Refer to the data for Lester Company in question # (X). What is the company's contribution margin ratio?
- (a) 0.60
  - (b) 0.40
  - (c) 1.67
  - (d) 20.00
- (xii) In the area of cost-volume-profit analysis, the contribution margin ratio shows how much each taka of sales contributes to:
- (a) Covering the fixed costs of the business and providing operating income.
  - (b) Fixed expenses and variable expenses.
  - (c) Variable expenses and interest charges.
  - (d) Variable expenses when production is at normal capacity.
- (xiii) A company's relevant range of production is?
- (a) The production range from zero to 100% plant capacity.
  - (b) The production range over which output may reasonably be expected to vary.
  - (c) The production range beyond the break-even point.
  - (d) The production range that covers fixed but not variable costs.
- (xiv) A 40% contribution margin ratio means that:
- (a) The company should contribute 40% of its operating income.
  - (b) 60% of the company's revenue is consumed by fixed and variable costs.
  - (c) The company's revenue has increased by 40% during the current accounting period.
  - (d) 40% of the company's revenue is available to cover fixed costs and to contribute toward operating income.

- (xv) Which of the following is not applied to a company's contribution margin?
- (a) It is the amount of revenue left over after fixed and variable costs have been paid.
  - (b) It may be expressed in total takas or on a per-unit basis.
  - (c) Part of it provides the company's operating profit.
  - (d) Expressed as a percentage of sales, it is called the contribution margin ratio.

**C. Descriptive Questions:**

1. "Cost-volume-Profit (C-V-P) analysis is based entirely on unit costs'. Do you agree? Explain.
2. What is cost-volume-profit analysis? What are its objectives? State the assumptions behind cost-volume-profit analysis.
3. What is meant by the term "cost-volume-profit" analysis? Why is this analysis important in business management?
4. In classifying a particular cost as fixed or variable, the volume or activity level is extremely important". Discuss and illustrates this statement.
5. What is contribution? How does it help the management in solving various business problems?
6. "The contribution approach is the foundation of C-V-P logic and related techniques" Discuss.
7. What are the assumptions underlying cost-volume-profit analysis? Since these assumptions may not meet in any given situation, are the results of CVP analysis totally useless to management?
8. What is the difference between a company's gross margin at its total contribution margin?
9. What does the term relevant range mean? Why is it important to consider what the relevant range is in individual applications?

**Key to Quizzes**

(i) T; (ii) F; (iii) F; (iv) T; (v) F; (vi) F; (vii) F; (viii) F; (ix) T; (x) T; (xi) F; (xii) T.

**Key to Multiple Choice Questions:**

(i) d; (ii) d; (iii) a; (iv) a; (v) c; (vi) a; (vii) c; (viii) d; (ix) a; (x) c; (xi) b; (xii) a; (xiii) b; (xiv) d; (xv) a.

## Lesson-2 : Break-Even Analysis

After completing this lesson, you should be able to :

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### Introduction

Break-even analysis is a technique that helps management accountants planning profit. Sometimes managers may wish to know the sales required to just cover fixed costs without earning any profit or showing any loss. In a business context, the break-even analysis is of interest if managers have a reasonably good idea of future sales levels and want to know how much cushion they have between expected sales and sales at break-even. The break-even analysis is the most widely known form of the cost-volume -profit analysis. The study of CVP/CPV analysis is frequently referred to as break-even analysis. However, some state that up to the point of activity where total revenue equals total expenses, the study can be called as break-even analysis, while, beyond that point, it is the application of cost-volume profit analysis. But this concept is not widely used.

### Meaning of Break-Even Analysis

*The point of sales volume (in units or in money value), at which total cost is equal to total revenue, is identified under the cost-volume-profit analysis as the break-even point.*

Break - even analysis is a second key relationship in cost-volume profit analysis where the level of activity at which total revenues equal total costs, both fixed and variable. This level of activity is called break-even level. The point of sales volume (in units or in money value), at which total cost is equal to total revenue, is identified under the cost-volume-profit analysis as the break-even point. It is also known as no profit no loss point because at this point the organization's revenues and expenses are equal i.e. the organization's has no profit no loss; it breaks even.

If the production and sales exceed the break-even point profit earning process starts. In a reverse manner if the production and sales fall below this level, operating costs are not covered and the firm suffers a loss. So, break-even analysis is useful for evaluating organization's alternatives and the change in profitability with changes in production and sales activity levels.

### **Assumptions of Break -Even Analysis:**

Before the student draws any conclusions with respect to the accuracy of or the desirability of the break-even point, it is essential that he is

acquainted with the assumptions which have been made in this analysis. The underlying assumptions of a break-even point are given below:

- a) The behavior of cost and revenue has been reliably determined and is linear over the relevant range. The relevant range of activity is a range of activity in which the fixed costs do not respond to changes in activity.
- b) All costs are divided into fixed and variable.
- c) Fixed costs will remain constant over the relevant volume range of the break even analysis.
- d) Variable costs are proportional to volume.
- e) Selling price are to be unchanged.
- f) Prices of cost factors are to be unchanged.
- g) Efficiency and productivity are to be unchanged.
- h) The analysis either covers a single product or it assumes that a given sales mix will be maintained as total volume changes.
- i) Revenue and costs are being compared on a common activity base.
- j) Perhaps the most basic assumption is that volume is the only relevant factor affecting cost. Of course, other factors also affect costs and sales. Ordinarily cost-volume-profit analysis is a crude over simplification when these factors are unjustifiably ignored.
- k) Changes in beginning and ending inventory levels are insignificant amount.

***Uses of Break -Even Analysis:***

Break -even analysis may be used by management accountants and executives as a tool in the decision -making process. It may give some guidelines for taking optimum decisions. Some of the uses of the break-even analysis are given below:

- (a) A sales manager can have the idea about the sales volume that must be sold either to make desired amount of profit or to break-even.
- (b) A producer may know the percentage of capacity to be utilized to cover the amount of fixed costs.
- (c) Management can know the effect of changes in selling price, volume of sales and costs of production on profitability.
- (d) Management can use it to find out the comparative profitability of product lines.
- (e) It may be used to determine the suitability of alternative machineries.

- (f) It may help the management in the following situations:
- (i) Determine the optimum sales volume.
  - (ii) Suggestions for shift in sales mix.
  - (iii) Acceptance of special orders.
  - (iv) Changes in fixed costs.

### Break -Even Computation

As stated in the definition break -even point can be expressed either in sales taka or sales units and can be approached in three following ways.

1. Computed from a mathematical equation.
2. Computed by using contribution margin.
3. Derived from a cost-volume-profit (CVP) graph and break-even chart.

**1. Mathematical Equation Approach:** Under the mathematical equation approach break-even can easily be computed based on the profit equation. We know that, income( or profit) is equal to sales revenue minus expenses. Keeping in mind that expenses are separated in to fixed and variable expenses , the essence of income (profit) statement is captured in the equation form as follows:

$$\begin{aligned} & \text{Sales revenue} - \\ & \text{Variable expenses} - \\ & \text{Fixed expenses} = \\ & \text{Profit} \end{aligned}$$

$$\text{Sales revenue} - \text{Variable expenses} - \text{Fixed expenses} = \text{Profit}$$

Taking the above equation little bit further, it can be restated as follows:

$$[(\text{unit sales price}) \times (\text{sales volume in units})] - [(\text{unit variable expenses}) \times (\text{sales volume in units})] - (\text{fixed expenses}) = \text{profit}$$

Since it cannot be known how many units would have to be sold in order to know break- even, we substitute the letter X in the equation for sales volume in units, and as at the break-even point profit is zero, let net income (profit) = 0, or break-even. Therefore, the break-even point can be computed by finding the point where sales i.e. X just equal the total of the variable expenses plus the fixed expenses.

**2. Contribution Margin Approach:** As mentioned in the previous lesson, contribution margin equals the difference between total revenues and total variable costs of sales. In fact this approach is actually just a shortcut version of the mathematical equation approach. The approach centers on the idea that at the break -even point, contribution margin must equal total fixed costs. On the basis of this relationship, we can find out break-even point by using either the contribution margin per unit or the contribution margin ratio or M/I ratio or P/V ratio.

When the contribution margin per unit is used, the general formula for computing the break-even sales volume in units is given below:



$$\text{Break-even point (in units)} = \frac{\text{Fixed Costs}}{\text{Unit contribution per unit}}$$

Sometimes management prefers to determine break-even point in sales taka rather than units. The following formula provides an alternative method to determine the break-even point in sales taka.

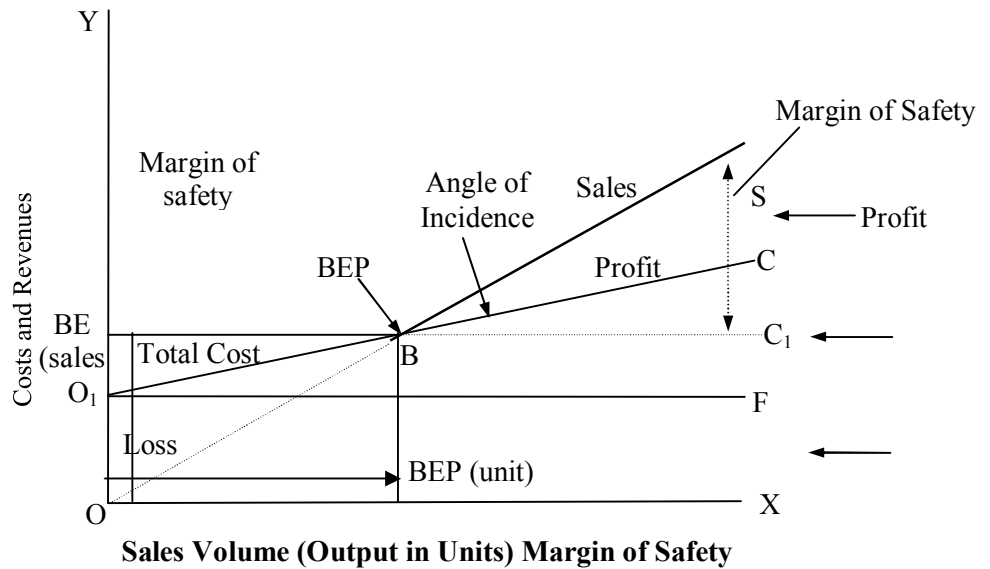
$$\text{Break-even point (in sales taka)} = \frac{\text{Fixed Costs}}{\frac{\text{Unit contribution margin}}{\text{Unit sales price}}}$$

As we have mentioned earlier that unit contribution margin divided by the unit sales price is called the contribution margin ratio, the above formula can be rearranged as follows:

$$\text{Break-even point (in sales taka)} = \frac{\text{Fixed Cost}}{\text{Contribution ratio}}$$

Both the methods are same approaches for determining the break -even point. Selecting between the two is based on personal preference. But the contribution margin approach enjoys an added advantage over mathematical approach because the latter method is useful in those situations where an organization has multiple product lines and wishes to determine a single break-even point for the organization as a whole.

- 3. Cost-Volume -Profit (CVP) Graphic Presentation:** An effective way to derive the break-even point is to prepare a break -even graph. A break - even graph is a graphic approach to the study of the relationship of cost, revenue and profit. Because this graph also shows costs, volume , and profits, it is referred to as the cost-volume-profit (CVP) graph. The graphic presentation instead of other methods discussed earlier is often used because it tends to be more easily understood by persons whose acquaintance with mathematics is minimal and because it provides an immediate view of variable expenses, fixed expenses and profit at any level of activity.



### Sales volume (Output in Units)

We can illustrate break even analysis by means of the above graph. Such a graph is often referred to as a break even chart, which depicts sales revenues, and fixed, variable, and total costs, with a break even point at the intersection of the sales revenue and total cost curve.

The following steps are used to prepare CVP graph.

- Step 1 : Sales volume (output in units) is shown in OX horizontal axis.
- Step 2 : Costs and Revenues is shown in OY vertical axis.
- Step 3 : O<sub>1</sub>F line is drawn which is the total cost curve and parallel to the OX horizontal axis because fixed costs are constant at all activity levels.
- Step 4 : OS is the Total sales revenue curve which intercept the fixed costs line and O<sub>1</sub>C is the variable costs curve.
- Step 5 : At point B total costs and total sales are equal because at this point the sales revenue curve has intersected the total costs curve. This B point is the break-even point. So the break even point is indicated by the point at which the total cost curve intersects the total sales revenue curve, because profit equals zero when total costs equals total sales revenues.
- Step 6 : FX is the fixed costs, CF is the variable costs and SC is the profit earned.
- Step 7 : The area of the triangle SBC is the profit earning area, while SBC<sub>1</sub> is the area indicating margin of safety.

*The break even point is indicated by the point at which the total cost curve intersects the total sales revenue curve.*

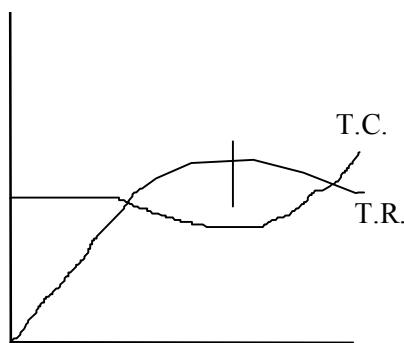
Step 8 : The angle lying in the right side of the point of intersection of the sales revenue curve and total cost curve (i.e. point B) is the angle of incidence. So  $\angle SBC$  is the angle of incidence. This angle explains the interrelation between sales and profit. It also indicates the profit earning capacity of organization over its break-even level of sales. A large angle of incidence is an indicator of high profit margin and vice-versa.

*Angle lying in the right side of the point of intersection of the sales revenue curve and total cost curve (i.e. point B) is the angle of incidence.*

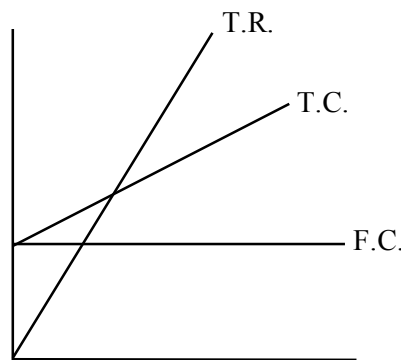
In addition to identifying the break-even point, the CVP graph also depicts the loss area. It is very useful because the effects of a change in any elements in the CVP analysis can be easily portrayed and observed.

### Break-even Point: Accounting Viewpoint vs Economics Viewpoint

The accountants and the economists draw break-even charts in two different ways as shown below:



**Economists' Break-even chart**



**Accountants' Break-even chart**

(i) Accountants assume that variable costs per unit will remain constant with the change in volume, Economists do not do it.

(ii) Accountant draw the sales line on the assumption that selling price per unit will not change with the change in production volume. The economists assume that the price will go down with the increase in supply.

The economies and diseconomies of scale are taken into account by the economists. The economists, break-even chart is more realistic, but it will be relatively expensive. The accountants' one is simple and less costly.

### Limitations of Break-even Analysis

The break-even analysis is a deterministic one. The major limitations of a break-even analysis stem from the fact that it is subject to certain assumptions which make the same unrealistic. The assumptions are as follows:

- (i) Exact and accurate classification of costs into fixed and variable is not possible in real world. Fixed costs vary beyond a certain level of output. Variable per units is constant and it varies in preparation to the volume.
- (ii) Constant selling price is not true. A change in price may increase or decrease sales volume.
- (iii) Total variable costs are proportional to volume. This may not be true. With the increase in volume of sales, total variable costs may increase with a decreasing rate.
- (iv) Prices of factors of production - material, labor etc. are to be unchanged. Management should carefully bear this at the time of using break-even analysis.
- (v) Efficiency and productivity are to be unchanged. But in reality, these change with the changes in volume of production, labor mix, experience etc.
- (vi) Importance is given to opening and closing inventory.
- (vii) Product mix will remain unchanged. But market may not behave as expected.
- (viii) Units of measurement for various products are identical. This may not always be true.
- (ix) The behavior of total costs and total revenues is linear. In real world situation, this is a rare event.

Therefore, the particular assumptions limit the use of break-even analysis in all situations.

**Demonstration Problem**

**Problem no. 6.2.1**

The annual profit plan of the PM Ltd. is given in the following table. From the data given in the table, calculate the break-even point.

	Fixed expenses Tk.	Variable expenses Tk.	Total Tk.
Budgeted sales (20,000 units @ Tk.20)			4,00,000
Budgeted Costs:			
Direct labor		70,000	
Direct material		1,00,000	
Manufacturing overhead	64,000	20,000	
Administrative expenses	50,000	10,000	
Distribution expenses	30,000	20,000	
Total	1,44,000	2,20,000	3,64,000
Budgeted Profit			36,000

Capacity of production : 25,000 units.

**Solution to the Demonstration Problem**

$$\begin{aligned} \text{Contribution margin} &= \text{Sales} - \text{Variable costs} \\ &= (\text{Tk.}4,00,000 - \text{Tk.}2,20,000) = \text{Tk.}1,80,000 \\ &\quad \text{Total Contribution Margin} \end{aligned}$$

$$\therefore \text{Contribution margin per unit} = \frac{\text{Total Contribution Margin}}{\text{Units sold}}$$

$$= \frac{\text{Tk.}1,80,000}{20,000 \text{ units}} = \text{Tk.}9$$

$$\therefore \text{Break-even point (in units)} = \frac{\text{Fixed Expenses}}{\text{Unit Contribution margin}}$$

$$= \frac{\text{Tk.}1,44,000}{\text{Tk.}9} = 16,000 \text{ units.}$$

$$\begin{aligned} \text{Break-even sales (in taka)} &= \text{break even units} \times \text{selling price} \\ &= 16,000 \text{ units} \times \text{Tk.}20 \\ &= \text{Tk.}3,20,000 \end{aligned}$$

Alternatively,

$$\begin{aligned} \text{Break-even point (in taka)} &= \frac{\text{Fixed expenses}}{\text{Unit Contribution}} \\ &= \frac{\text{Tk.1,44,000}}{9} = \text{Tk.3,20,000} \\ &\quad \frac{20}{20} \end{aligned}$$

**Problem no. 6.2.2**

The Campus Barber Shop employs four barbers. One Barber, who also serves as the manager, is paid a salary of Tk.1,200 per month. The other barbers are paid Tk.1,000 per month. In addition, each barber is paid a commission of Tk.4 per haircut, depreciation on equipment Tk.500, barber supplies 40 paisa per haircut, utilities Tk.300, and advertising Tk.200. The price of a haircut is Tk.10.

**Required:**

- (a) Determine the variable cost per haircut and the total monthly fixed costs.
- (b) Compute the break-even point in units and takas.
- (c) Prepare a CVP graph, assuming a maximum of 1800 haircuts in a month. Use increments of 300 haircuts on the horizontal axis and in 3,000 increments on the vertical axis.
- (d) Determine the net income, assuming 1,400 haircuts are given in a month.

**Solution to the Demonstration Problem**

- (a) Calculation of Variable costs (per haircut)

Barber's commission	Tk.4.00
<i>Store rent</i>	<u>0.6</u>
Barber supplies	0.40
	<b><u>Tk.5.00</u></b>

Calculation of Fixed costs (per month)

Barber's salaries (1200+1000+1000+1000)	Tk.4200
<i>Store rent</i>	<u>800</u>
Depreciation on equipment	500
Utilities	300
Advertising	200
	<b><u>Tk.6,000</u></b>

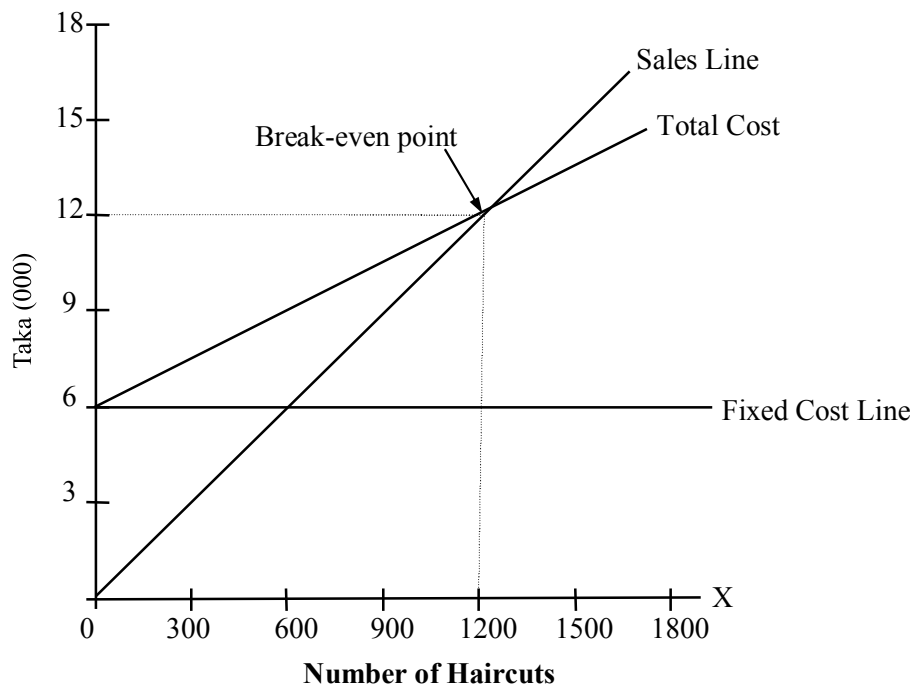
(b)  $\text{Selling Price} \times \text{Units sold} = \text{Variable Costs} + \text{Fixed Costs}$   
 or,  $\text{Tk.}10 X = \text{Tk.}5X + \text{Tk.}6000$   
 or,  $\text{Tk.}5X = \text{Tk.}6000$   
 $\therefore X = 1200 \text{ units}$

Again Break-even sales (in Tk.) = Variable Costs + Fixed Costs  
 $X = 0.50 X + \text{Tk.}6000$   
 $0.50X = \text{Tk.}6000$   
 $X = 6000/0.50 = \text{Tk.}12,000$

or

Break-even sales (in Tk.) =  $1200 \text{ units} \times \text{Tk.}10 \text{ per haircut} = \text{Tk.}12,000$

(c)



(d)  $\text{Net Income} = \text{Sales} - (\text{Variable Cost} + \text{Fixed Costs})$   
 $\text{Net Income} = (1,400 \text{ haircuts} \times \text{Tk.}10) - [(1,400 \text{ haircuts} \times \text{Tk.}5.00) + \text{Tk.}6,000]$   
 $= \text{Tk.}14,000 - \text{Tk.}13,000$   
 $\therefore \text{Net Income} = \text{Tk.}1,000$

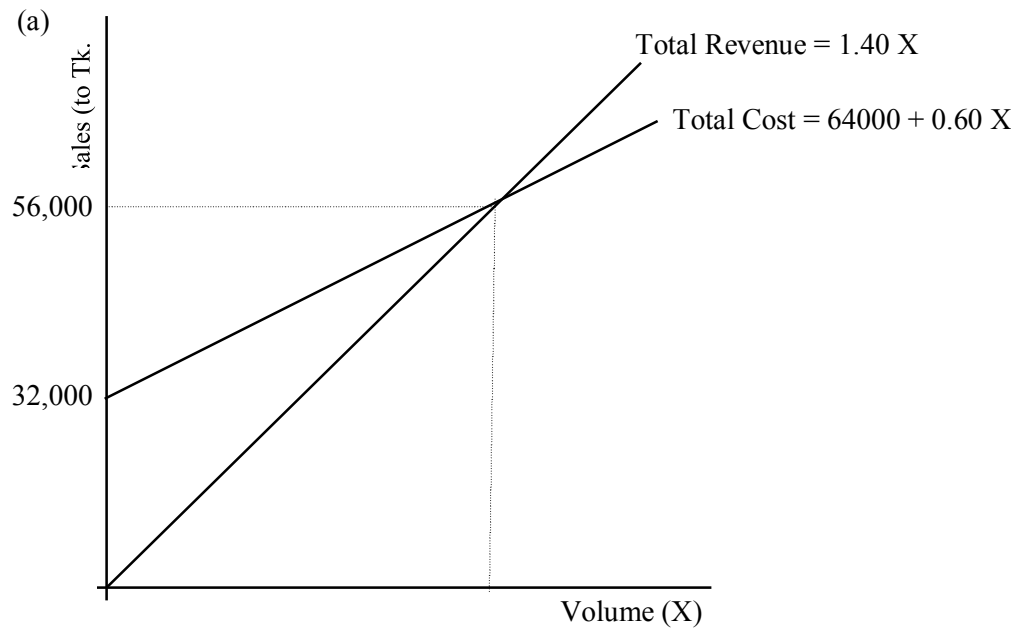
**Problem no. 6.2.3**

Shafkat and Sanjana, two recent business school graduates, have decided to open their own copy service business on a part time basis. They estimate that their annual fixed costs are Tk.64,000 and their average variable cost for each copy sold at Tk.0.60. They expect their selling price to average Tk.1.40 per copy.

**Required:**

- (a) Draw the break-even chart for their business, and indicate all the relevant costs.
- (b) What is their break-even point in Taka? In number of copies?
- (c) After their final year of operations, in which they generated Tk.1,68,000 in revenue, Shafkat and Sanjana decide to pay themselves each Tk.10,000 per year in salaries. What does their annual sales now have to be if they want to make the same amount of profit as they did in their final year?

**Solution to the Demonstration Problem**



**Note : Graph is not to scale**

- (b) Break-even point (in units) = Variable costs + Fixed Costs  
 $1.40 X = 0.60 X + \text{Tk.}64,000$   
or,  $\text{Tk.}0.80 X = \text{Tk.}64,000$   
 $\therefore X = 80,000$  copies.

Again Break-even point Sales = Variable Cost + Fixed Cost

$$\begin{aligned} \Rightarrow X &= 0.60 X + \text{Tk.}64000 \\ \Rightarrow X &= 0.60(80,000) + \text{Tk.}64,000 \\ \Rightarrow X &= 48,000 + 64,000 \\ \Rightarrow X &= \text{Tk.}1,12,000 \end{aligned}$$



(c) Selling price per copy = Tk.1.40, Total Revenue (Tk.) = Tk.1,68,000

Number of copies = Tk.1,68,000/Tk.1.40 = 1,20,000 copies.

Total Cost (TC) = Tk.64,000 + Tk.0.60 X 1,20,000 copies  
= Tk.1,36,000

∴ Profit = TR – TC  
= Tk.1,68,000 – Tk.1,36,000 = Tk.32,000 for the first year.

Fixed Cost for the next year : Tk.64,000 + 2(Tk.10,000) = Tk.84,000

∴ Profit = TR – TC

$$\Rightarrow \text{Tk.32,000} = (1.40 X - (\text{Tk.84,000} + 0.60 X))$$

$$\Rightarrow 32,000 = 1.40 X - \text{Tk.84,000} - 0.60 X$$

$$\Rightarrow 32,000 = 0.80 X - \text{Tk.84,000}$$

$$\Rightarrow 0.80X = \text{Tk.1,16,000}$$

$$\therefore X = 1,16,000/0.80 = 1,45,000 \text{ copies}$$

## **ASSIGNMENT MATERIALS**

### **A. Quizzes Questions:**

#### **1. Which of the following statements are true and which are false?**

- (i) At break-even point, the total cost and the total revenue may or may not be the same.
- (ii) The volume of output which causes fixed costs to be equal in amount to variable costs is called the break-even point.
- (iii) In Break-even analysis it is assumed that variable cost will vary with production in direct ratio and fixed cost will remain fixed.
- (iv) The break-even point occurs where the contribution margin is equal to total variable expenses.
- (v) One of the assumptions of break-even analysis is that there is no change in inventories.
- (vi) In real life situations "Break-even charts" are usually curvilinear and might show more than one break-even point.
- (vii) The break-even point can be expressed either in terms of units sold or in terms of total sales taka.
- (viii) At volume levels above the break-even point, a cost-volume-profit graph will show the revenue line to be above the total cost line.
- (ix) Once the break-even point has been reached, net income will increase by the unit contribution margin for each additional unit sold.
- (x) One way to compute the break-even point is to divide total sales by the contribution margin ratio.

### **B. Multiple Choice Questions:**

#### **2. Choose the best answer for each of the following questions by placing the identifying letter in the space provided to the left.**

- (i) The break-even point in a cost volume profit graph is always found:
  - (a) At 50% of full capacity.
  - (b) At the sales volume resulting in the lowest average unit cost.
  - (c) At the volume at which total revenue equals total variable costs.
  - (d) At the volume at which total revenue equals total fixed costs plus total variable costs.
- (ii) Which of the following will cause the break-even point to decrease?
  - (a) a decrease in the contribution margin per unit.
  - (b) an increase in the unit sales price.
  - (c) an increase in the unit variable costs.
  - (d) all of the above.

- (iii) As a company's sales move further from its break-even point, one would expect the degree of operating leverage to :
- (a) decrease
  - (b) increase
  - (c) remain unchanged
  - (d) vary in direct proportion to change in the activity level.
- (iv) One of the following is not involved in CVP analysis. That factor is:
- (a) sales mix
  - (b) unit selling price
  - (c) Fixed cost per unit
  - (d) volume or level of activity.
- (v) Sales are Tk.1,00,000 (500 units), variable costs are Tk.60,000, fixed costs are Tk.24,000. If selling price is reduced by 10% which of the following is the break-even sales quantity?
- (a) 450 units
  - (b) 500 units
  - (c) 400 units
  - (d) 334 units
- (vi) Which of the following is true at break-even point?
- (a) Sales revenue = Variable costs
  - (b) Profit = Fixed Cost + Variable Cost
  - (c) Sales revenue = total Cost - Variable Cost
  - (d) Contribution = Fixed Cost
- (vii) The break-even point will
- (a) increase if sales increase
  - (b) decrease if sales decrease
  - (c) increase if variable costs increase
  - (d) decrease if variable costs increase
- (viii) At a break-even point of 400 units sold, the variable costs were Tk.400 and the fixed costs were Tk.200. What will the 401st unit sold contribution to profit before income taxes?
- (a) 0
  - (b) Tk.0.50
  - (c) Tk.1.00
  - (d) Tk.1.50

- (ix) Agni Company has a single product. The selling price is Tk.50 and the variable cost is Tk.30 per unit. The company's fixed expenses are Tk.2,00,000 per month. What is the company's break-even in sales taka?
- (a) Tk.5,00,000
  - (b) Tk.33,333
  - (c) Tk.2,00,000
  - (d) Tk.4,00,000
- (x) In comparison to selling a product with a low contribution margin ratio, selling a product with a high contribution margin ratio always:
- (a) Requires less taka sales volume to cover a given level of fixed costs,
  - (b) Results in a greater margin of safety
  - (c) Results in a higher operating income
  - (d) Results in a higher contribution margin per unit sold.
- (xi) The break-even point in a given situation would be decreased by an increase in :
- (a) the ratio of variable costs to sales
  - (b) the CM ratio
  - (c) total fixed costs
  - (d) none of the above.
- (xii) The most important use of the cost volume profit graph is to show :
- (a) the break-even point
  - (b) the CM ratio at various levels of sales activity
  - (c) the relationship between volume, costs, and revenue over wide range of activity
  - (d) none of these.

**(C) Descriptive Questions**

1. Define "Break-even point". Discuss how it is determined.
2. What are the underlying assumptions in break-even analysis? Enumerate those assumptions.
3. What are the principal difference between the economist's and the accountant's break-even models?
4. What do you understand by the term "break-even point?" Why should it be calculated?
5. "Break-even analysis is of limited use to management because a company cannot survive by just breaking even. Do you agree? Explain.

6. What is Break-even Chart? State the methods and purpose of constructing such chart.
7. What are the limitations of break-even analysis?
8. "A break-even chart must be interpreted in the light of the limitations of its underlying assumptions" Discuss.
9. How do the following reflect on break-even volume?
  - (i) Increase in total fixed cost
  - (ii) Increase in total physical sales; and
  - (iii) Decrease in variable cost per unit.
10. Briefly explain each of the following methods of computing a break-even point in units.
  - (i) contribution margin approach
  - (ii) equation approach, and
  - (iii) graphical approach.

***Key to Quizzes***

(i) F; (ii) F; (iii) T; (iv) F; (v) T; (vi) ; (vii) T; (viii) T; (ix) T; (x) F.

***Key to Multiple Choice Questions:***

### Lesson-3: Margin of Safety and Sales Mix

After completing this lesson, you should be able to :

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#### Introduction

Earlier in this unit we have discussed the use of cost-volume-profit analysis for managerial decision making. To recapitulate, managers must understand the interrelationship of cost, volume, and profit for planning and decision-making. Moreover, in making decision, the executives need to understand relationships between selling prices, sales, volume, and costs. They also need to understand the volume of sales at which the firm's revenues and total costs will be exactly equal. In this lesson we will look in another relationship and several common applications in cost-volume-profit analysis.

#### *Margin of Safety:*

*Margin of safety is the difference between actual or expected sales and sales at the break-even point.*

Margin of safety is the difference between actual or expected sales and sales at the break-even point. In other words, the margin of safety or safety margin of an enterprise is the difference between the budgeted sales revenue and break-even sales revenue. So, this tells the managers the margin between current sales and the break-even point. In a sense, margin of safety indicates the risk that an organization faces of losing money. That is, the margin by which sales can fall before the organization is in the loss area. In other words, margin of safety refers to the amount by which sales revenue can fall before a loss is incurred.

The margin of safety serves as a guide and is a reliable indicator of the organizations strength and soundness because even with substantial fall in sales volume or fall in production, some profit can be made. Narrow margin of safety, on the other hand, is a pointer of the weak position of the organization and even a small reduction in sales volume and production will adversely affect the profit position of the organization. Margin of safety can be expressed in absolute sales amount or in percentages.

The formula for stating the margin of safety in taka is :

**Actual (Expected Sales) - Break-even Sales = Margin of Safety (in taka)**

In contrast., the formula for determining the margin of safety ratio is:

**Margin of Safety( in taka) ÷ Actual (Expected Sales) = Margin of Safety ratio**

***Profit -Volume Ratio:***

Profit-volume ratio is also memorized as " Marginal Income Ratio". The ratio that is used to analyze the relation between contribution and sales is known as profit-volume ratio. The more appropriate term might be the Contribution Margin Ratio. It is the relationship between marginal income and marginal sales volume. This ratio is also called contribution-sales ratio or marginal income ratio or variable profit ratio. This is often expressed as a percentage. Generally it is calculated as follows:

*The ratio that is used to analyze the relation between contribution and sales is known as profit-volume ratio.*

$$1 - \frac{\text{Variable cost of sales}}{\text{Total Sales Taka}} = \text{Profit-volume ratio(P/V ratio)}$$

There are other ways to calculate P/V ratio:

$$\text{Profit-volume ratio (P/V ratio)} = \frac{\text{Contribution}}{\text{Sales}} \times 100$$

$$\text{Profit-volume ratio (P/V ratio)} = \frac{\text{Changes in contribution}}{\text{Changes in sales}} \times 100$$

Profit -volume ratio is a significant tool of cost-volume profit analysis. The rate of profitability can be measured through this ratio. A high P/V ratio indicates high profitability and a low ratio indicates low profitability of the firm.

It is also closely connected to the break-even analysis. For calculating the amount of break-even sales, the amount of fixed cost is divided by the P/V ratio. The formula for calculating break even sales is given below:

$$\text{Break-Even Sales} = \frac{\text{Fixed costs}}{\text{P/V ratio}}$$

Profit volume ratio may be augmented either by increasing the selling price or by reducing the variable costs or both. The adequacy of the margin of safety should be evaluated by management in terms of such factors as the vulnerability of the product to competitive strain and to stagnation in the economy.

***Target Net Income:***

Sometimes management want to know the sales required to earn a particular profit that they have set as an objective. This objective called target net income is extremely useful to management because it indicates the sales necessary to achieve a specified level of income. The matter of

finding the volume of sales required to earn a particular target net income is very similar to the problem of finding the break-even point. The amount of sales necessary to achieve target net income can be determined from each of the following modified approaches used in determining break-even sales.

1. Mathematical Equation
2. Contribution Margin Technique
3. Graphic Presentation.

**1. Mathematical Equation:** We know that at the break-even point no profit no loss results for the organization. To modify by adding a factor for target net income to the break-even equation stated in the lesson 2, we obtain the following formula for determining required sales.

$$\text{Target net income} = [(\text{Unit sales price}) \times (\text{sales volume required to earn target net income})] - [(\text{Unit variable expenses}) \times (\text{sales volume required to earn target net income}) - (\text{Fixed expenses})]$$

Since it can not be known sales volume required to earn target net income, we substitute the letter X in the equation for sales volume required to earn target net income. Therefore, sales volume required to earn target net income can be computed by finding the value of X.

**2. Contribution Margin Technique:** The unit contribution margin and contribution margin ratio may be used in calculating income and sales required to earn particular target net income. When the contribution margin ratio is used to solve for required sales volume, the required volume is expressed in sales taka , rather than sales units. The total taka sales required to earn a target net income is determined as follows:

$$\text{Taka sales required to earn target net profit} = \frac{\text{Fixed Expenses} + \text{Target net profit}}{\text{Contribution margin ratio}}$$

On the other hand, with the help of unit contribution margin, number of sales units required to earn target net profit can be determined as follows:

$$\text{Number of sales units required to earn target net profit} = \frac{\text{Fixed expenses} + \text{target net profit}}{\text{Unit contribution}}$$

The contribution margin ratio has a distinct advantage over the unit contribution margin when the organization has more than one product.

*In the profit area of the graph, the distance between the sales line and the cost line at any point depicts net income.*

**3. Graphic Presentation:** Cost-volume -profit graph presented in the lesson 2, shows profit and loss area for various levels of sales volume, which enables executives to examine the sales revenue or units required to attain different levels of target net income. In the profit area of the graph, the distance between the sales line and the cost line at any point depicts net income. One of the important advantage of CVP graph is that



any targeted net income and its related sales figure can easily be demonstrated (within the range included in the graph) without performing separate calculations for each case.

**Target Return on Sales:** As executives are interested in many types of analysis, they sometimes wish to earn a net income that is a given percentage of sales. This ratio, income/ sales, is called return on sales and is frequently used a measure of profitability. In simplified formula form, the sales required is calculated as follows:

$$\text{Sales required} = \frac{\text{Fixed Expenses}}{\text{Contribution margin ratio} - \text{Target return on sales}}$$

The logic behind this formula is that of each taka of sales, some percent (variable -cost ratio) goes to covering fixed expenses and some percentage goes to providing the desired return on sales.

### **Sales Mix:**

In the foregoing discussion, we have concentrated our discussion only on one product. Sales mix- is a term that has meaning only for a multi-product firm. In simple words, the term sales mix means the relative proportions in which a organization's products are sold. In other words sales mix refers to the proportionate quantities of the products that make up the total sales of the company. The sales mix for a multi-product firm represents the percentage of total sales that is distributed to each product line. The sales mix percentage for each product line can be calculated as follows:

$$\text{Sales mix \%} = \frac{\text{Sales of individual product line}}{\text{Sales of all product lines combined}}$$

The term sales mix is an weighty assumption in multi-product CVP analysis. Break-even sales can be computed for a mix of two or more products by determining the weighted average unit contribution margin of all the products. The sales mix is used to compute a weighted average unit contribution margin. This is the average of the several products' unit contribution margin, weighted by the relative sales proportion of each product.

The organization's break-even point in units is computed using the following method:

$$\text{Break-even point} = \frac{\text{Fixed expenses}}{\text{Weighted average unit contribution margin}}$$

Management should analysis the company's sales mix by investigating the impact on profit of changes in sales volume, prices, variable expenses, fixed expenses, or the sales mix itself. Some important factors

affecting the sales mix of a company are product selling price, sales force compensation, and advertising expenditures. A change in one or all of these factors may cause a company's sales mix to shift. At any levels of units sold, net income will be greater if more high contribution margin units are sold than low contribution margin units. Furthermore, an analysis of this connection reveals that a shift from low-margin sales to high -margin sales may increase net income, even though there is a decline in total units sold. Correspondingly, a shift from high-to low-margin sales may result in a decrease in net income, even despite there is an addition in total units sold.

**Demonstration Problem**

**Problem No. 6.3.1**

Moti Company makes pocket diary that sells for Tk.40 each. For the coming year, management expects fixed costs to totaled Tk.4,40,000 and variable costs to be Tk.18.00 per unit.

**Required:**

- (a) Compute break-even sales in taka using mathematical equation.
- (b) Compute break-even sales using the contribution margin (CM) ratio.
- (c) Compute the margin of safety percentage assuming actual sales are Tk.10,00,000.
- (d) Compute the sales required to earn net income of Tk.3,30,000.

**Solution to the Demonstration Problem**

(a) Break-even Sales = Variable costs + Fixed costs  

$$\therefore X = \left( \frac{\text{Tk.18}}{\text{Tk.40}} \right) X + \text{Tk.4,40,000}$$

$$X = 0.45 X + 4,40,000$$

$$0.55 X = 4,40,000$$

$$\therefore X = \text{Tk.8,00,000}$$

(b) Contribution Margin per unit = Unit selling price - Unit variable costs  

$$= (\text{Tk.40} - \text{Tk.18})$$

$$= \text{Tk.22}$$

$$\text{Contribution margin ratio} = \frac{\text{Contribution Margin per unit}}{\text{Unit selling price}} \times 100$$

$$= \frac{\text{Tk.22}}{\text{Tk.40}} \times 100 = 55\%$$

$$\text{Bank-even Sales} = \frac{\text{Fixed Costs}}{\text{Contribution Margin ratio}}$$

$$\begin{aligned} & \text{Tk.4,40,000} \\ & = \frac{\text{-----}}{55\%} \\ & = \text{Tk.8,00,000} \end{aligned}$$

(c) Margin of Safety ratio =  $\frac{\text{Actual sales - Break-even Sales}}{\text{Actual sales}}$

$$\begin{aligned} & = \frac{\text{Tk.10,00,000 - Tk.8,00,000}}{\text{Tk.10,00,000}} \\ & = 20\% \end{aligned}$$

(d) Required Sales = Total Variable Costs + Fixed Costs + Net Income

$$\begin{aligned} X &= 0.45 X + \text{Tk.4,40,000} + \text{Tk.3,30,000} \\ X .55 X &= \text{Tk.7,70,000} \\ \therefore X &= \text{Tk.14,00,000} \end{aligned}$$

**Problem No. 6.3.2**

BOL Ltd. furnished you the following information relating to the half year ended 30th June, 2004.

Fixed Costs	Tk.50,000
Sales value	Tk.2,00,000
Profit	Tk.50,000

During the second half of the same year the company has projected a loss of Tk.10,000.

**Required:**

- (a) The P/V ratio, break-even point and the margin of safety and margin of safety ratio for six months ended 30th June, 2004.
- (b) Expected sales volume for second half of the year assuming that selling price and fixed expenses remain unchanged in the second half year also.
- (c) The break even point and the margin of safety for the whole year 2004.

**Solution to the Demonstration Problem**

$$\begin{aligned} \text{Contribution} &= \text{Fixed Costs} + \text{Profits} \\ &= \text{Tk.50,000} + \text{Tk.50,000} \\ &= \text{Tk.1,00,000} \end{aligned}$$

(a) Profit volume ratio (P/V ratio) =  $\frac{\text{Contribution}}{\text{Sales}} \times 100$

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

$$\text{Break even Point} = \frac{\text{Fixed Costs}}{\text{P/V ratio}}$$

$$= \frac{\text{Tk.50,000}}{50\%} = \text{Tk.1,00,000}$$

$$\begin{aligned} \text{Margin of safety} &= \text{Actual sales} - \text{Break-even sales} \\ &= \text{Tk.2,00,000} - \text{Tk.1,00,000} \\ &= \text{Tk.1,00,000} \end{aligned}$$

$$\text{Margin of safety ratio} = \frac{\text{Margin of safety (in taka)}}{\text{Actual sales}} \times 100$$

$$= \frac{\text{Tk.10,000}}{\text{Tk.2,00,000}} \times 100 = 50\%$$

(b) Expected sales volume for the second half of the year.

$$\begin{aligned} \text{Contribution} &= \text{Fixed Costs} - \text{Loss} \\ &= \text{Tk.50,000} - \text{Tk.10,000} = \text{Tk.40,000} \end{aligned}$$

$$\text{Expected Sales} = \frac{\text{Contribution}}{\text{P/V ratio}}$$

$$= \frac{\text{Tk.40,000}}{50\%} = \text{Tk.80,000}$$

(c) Break-even point and margin of safety for the whole year.

Fixed costs for the whole year (50,000 X 2)	=	Tk.1,00,000
Profit (Tk.50,000 - Tk.10,000)	=	<u>Tk.40,000</u>
Contribution :		<u>Tk.1,40,000</u>

$$\text{Total sales volume for the whole year (Tk.2,00,000 + Tk.80,000)} = \text{Tk.2,80,000}$$

$$\text{Margin of Safety : Tk.280,000 - Tk.200,000} = \text{Tk.80,000}$$

### Self-Assessment Questions (SAQs)

#### A. Quizzes Questions:

1. Which of the following statements are true and which are false?

- (i) One of the key assumptions in break-even analysis is that the sales mix will not change.
- (ii) Margin of safety is the excess of actual sales over break even sales.
- (iii) A shift in sales mix toward less profitable products will cause the overall break-even point to fall.
- (iv) Margin of safety has got no relation with the fixed cost.
- (v) If the product mix changes, a break-even point that was valid in the past may no longer be valid.
- (vi) A high P/V ratio indicates that with a slight increase in volume, the profit of the firm can be significantly increased.
- (vii) A key assumption in break-even analysis when there is more than one product is that the sales mix will not change.
- (viii) As sales exceed the break-even point a high CM ratio will result in lower profits than will a low CM ratio.
- (ix) P/V ratio can be improved by reducing fixed cost.
- (x) In a cost volume profit graph, the taka amount by which actual sales exceed break-even sales volume is called the margin of safety.

#### B. Multiple Choice Questions:

2. Choose the best answer for each of the following questions by placing the identifying letter in the space provided to the left.
- (i) Under a multi-product situations, break-even point is calculated by using the ratio which is the
    - (a) simple average of the P/V ratio of all the products
    - (b) weighted average P/V ratio which takes into consideration the expected sales mix.
  - (ii) In multiple product firms, a shift in the sales mix from less profitable products to more profitable products will cause the company's break-even point to:
    - (a) increase
    - (b) decrease
    - (c) there will be no charge
    - (d) none of these.
  - (iii) The mathematical equation for computing required sales to obtain target net income is :
    - (a) Variable costs + Target net income

- (b) Variable costs + Fixed costs + Target net income
  - (c) Fixed costs + Target net income
  - (d) None of the above
- (iv) The following figures are taken from Parker Company's income statement; Net Income, Tk.30,000; Fixed Costs Tk.90,000; Sales Tk.2,00,000 and CM ratio is 60%. The company's margin of safety in taka is:
- (a) Tk.1,50,000
  - (b) Tk.30,000
  - (c) Tk.50,000
  - (d) None of these.
- (v) Refer to the data in question (v) above. The margin of safety in percentage form is :
- (a) 60 percent
  - (b) 75 percent
  - (c) 40 percent
  - (d) 25 percent
- (vi) Margin of safety may be improved by :
- (a) Increasing sales volume
  - (b) Lowering variable cost
  - (c) lowering fixed cost
  - (d) All the above.
- (vii) Glory Company is planning to sell 2,00,000 pocket calendar for Tk.4 per unit. The contribution margin ratio is 25%. If glory will break-even at this level of sales, what are the fixed costs?
- (a) Tk.1,00,000
  - (b) Tk.1,60,000
  - (c) Tk.2,00,000
  - (d) Tk.3,00,000
- (viii) When fixed cost is Tk.7,000, profit is Tk.3,000 and sales Tk.50,000. The P/V ratio is :
- (a) 14%
  - (b) 20%
  - (c) 25%
  - (d) Cannot be calculated.
- (ix) Noor Company had actual sales of Tk.6,00,000, when break-even sales were Tk.4,20,000 what is the margin of safety ratio?
- (a) 25%
  - (b) 30%
  - (c)  $33\frac{1}{3}\%$
  - (d) 45%
- (x) An increase in fixed costs will result in the following?
- (a) A decrease in the contribution : sales ratio

- (b) A decrease in the contribution per unit  
(c) An increase in the break even point sales level  
(d) An increase in the margin of safety.
- (xi) Hello Company has two products, X and Y, with the following total sales and total variable costs:
- |                      | Product X | Product Y |
|----------------------|-----------|-----------|
| Total Sales          | Tk.20,000 | Tk.40,000 |
| Total variable costs | Tk.8,000  | Tk.28,000 |
- (a) 70%  
(b) 50%  
(c) 30%  
(d) 40%
- (xii) Tony Company has sales of Tk.2,00,000 with variable expenses of Tk.1,50,000, fixed expenses of Tk.60,000, and an operating loss of Tk.10,000. By how much would Tom have to increase its sales in order to achieve an operating income of Tk.10% of sales.
- (a) Tk.4,00,000  
(b) Tk.2,51,000  
(c) Tk.2,31,000  
(d) Tk.2,00,000

### C. Descriptive Questions:

1. What information is conveyed by a cost-volume-profit graph in addition to a company's break-even point?
2. What does the term sales mix mean? How is a weighted average unit contribution margin computed?
3. (a) What do you know by margin of safety?  
(b) Explain the formula for computation of this margin.  
(c) How can the margin of safety be increased?
4. What are the similarities and differences between a CVP income statement and a traditional income statement?
5. An MBA student defines contribution margin as the amount of profit available to cover operating expenses. Is the any both in this definition? Discuss?
6. The rise of the margin of safety is an extremely valuable guide to the strength of the business. Discuss what are the possible steps to receptive the position when the "margin of safety" is unsatisfactory.
7. "The effect of price reduction is always to reduce the P/V ratio, to raise break-even point, and to station the margin of safety". Explain and illustrate with numerical examples.

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8. What is profit volume ratio? Describe its importance? How can it be imparted?
9. A firm's variable cost ratio is 30%, its fixed costs are Tk.3,50,000, and it wishes to earn a targeted income of Tk.1,40,000. Do you have enough information to compute the required sales in Taka? If so, how much sales revenue is needed to earn the targeted income? If not, what additional information is needed?
10. If there is a change in the sales mix, does the Contribution Margin ratio per mix (CMRM) normally remain unchanged? Explain.

***Key to Quizzes***

(i) T; (ii) T; (iii) T; (iv) F; (v) T; (vi) T; (vii) T; (viii) F; (ix) F; (x) .

***Key to Multiple Choice Questions:***

(i); (ii); (iii); (iv); (v); (vi); (vii); (viii); (ix); (x) .