

## **Chapter-03: Cost Volume Profit Analysis**

### **3.1: Introduction:**

Cost-volume-profit (CVP) analysis is a powerful tool that helps managers understand the relationships among cost, volume, and profit. The CVP analysis classifies all costs as either fixed or variable. Fixed costs are expenses that don't fluctuate directly with the volume of units produced. These costs effectively remain constant. An example of a fixed cost is rent. It doesn't matter how many units the assembly line produces. The rent expense will always be the same.

CVP analysis focuses on how profits are affected by the following five factors:

- a. Selling prices.
- b. Sales volume.
- c. Unit variable costs.
- d. Total fixed costs.
- e. Mix of products sold.

Because CVP analysis helps managers understand how profits are affected by these key factors, it is a vital tool in many business decisions. These decisions include what products and services to offer, what prices to charge, what marketing strategy to use, and what cost structure to implement.

### **3.2: Assumption of Cost-Volume-Profit (CVP) Analysis:**

Cost-volume-profit analysis is used to determine how changes in costs and volume affect a company's operating income and net income. In performing this analysis, there are several assumptions made, including:

- a. Sales price per unit is constant.
- b. Variable costs per unit are constant.
- c. Total fixed costs are constant.
- d. Everything produced is sold.
- e. Costs are only affected because activity changes.
- f. If a company sells more than one product, they are sold in the same mix.
- g. CVP analysis requires that all the company's costs, including manufacturing, selling, and administrative costs, be identified as variable or fixed.

Cost-volume-profit (CVP) analysis is a method of cost accounting that looks at the impact that varying levels of costs and volume have on operating profit. The cost-volume-profit analysis, also commonly known as break-even analysis, looks to determine the break-even point for different sales volumes and cost structures, which can be useful for managers making short-term economic decisions.

### 3.3: Application of CVP concepts:

**To reveal the effective of operating/marketing decisions:**

- Based on the relationship between variable costs, fixed costs, unit price and output volume.

**It is used to:**

- Set product price.
- Introduce a new product or determine an optimal mix.
- Replace equipment compare “make or buy” option.
- “Go no go decisions” determine breakeven point.

### 3.4: The Basics of Cost-Volume-Profit (CVP) Analysis:

Bob Luchinni’s preparation for his forthcoming meeting with Prem begins where our study of cost behavior in the preceding chapter left off—with the contribution income statement. The contribution income statement emphasizes the behavior of costs and therefore is extremely helpful to managers in judging the impact on profits of changes in selling price, cost, or volume. Bob will base his analysis on the following contribution income statement he prepared last month:

| Acoustic Concepts, Inc.<br>Contribution Income Statement<br>For the Month of June |           |          |
|---|-----------|----------|
|   | Total     | Per Unit |
| Sales (400 speakers) .....  | \$100,000 | \$250    |
| Variable expenses .....   | 60,000    | 150      |
| Contribution margin .....   | 40,000    | \$100    |
| Fixed expenses .....  | 35,000    |          |
| Net operating income .....  | \$ 5,000  |          |

Notice that sales, variable expenses, and contribution margin are expressed on a per unit basis as well as in total on this contribution income statement. The per unit figures will be very helpful to Bob in some of his calculations. Note that this contribution income statement has been prepared for management’s use inside the company and would not ordinarily be made available to those outside the company.

#### Contribution Margin:

As explained in the previous chapter, contribution margin is the amount remaining from sales revenue after variable expenses have been deducted. Thus, it is the amount available to cover fixed expenses and then to provide profits for the period. Notice the sequence here—contribution margin is used first to cover the fixed expenses, and then whatever remains goes toward profits. If the contribution margin is not sufficient to cover the fixed expenses, then a loss occurs for the

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period. To illustrate with an extreme example, assume that Acoustic Concepts sells only one speaker during a particular month. The company's income statement would appear as follows:

| Contribution Income Statement<br>Sales of 1 Speaker |                   |          |
|---|-------------------|----------|
|   | Total             | Per Unit |
| Sales (1 speaker) .....                             | \$ 250            | \$250    |
| Variable expenses .....                             | 150               | 150      |
| Contribution margin .....                           | 100               | \$100    |
| Fixed expenses .....                                | 35,000            |          |
| Net operating loss .....                            | <u>\$(34,900)</u> |          |

For each additional speaker the company sells during the month, \$100 more in contribution margin becomes available to help cover the fixed expenses. If a second speaker is sold, for example, then the total contribution margin will increase by \$100 (to a total of \$200) and the company's loss will decrease by \$100, to \$34,800:

| Contribution Income Statement<br>Sales of 2 Speakers |                   |          |
|--|-------------------|----------|
|  | Total             | Per Unit |
| Sales (2 speakers) .....                             | \$ 500            | \$250    |
| Variable expenses .....                              | 300               | 150      |
| Contribution margin .....                            | 200               | \$100    |
| Fixed expenses .....                                 | 35,000            |          |
| Net operating loss .....                             | <u>\$(34,800)</u> |          |

If enough speakers can be sold to generate \$35,000 in contribution margin, then all of the fixed expenses will be covered and the company will **break even** for the month—that is, it will show neither profit nor loss but just cover all of its costs. To reach the break-even point, the company will have to sell 350 speakers in a month, since each speaker sold yields \$100 in contribution margin:

| Contribution Income Statement<br>Sales of 350 Speakers |             |          |
|--|-------------|----------|
|  | Total       | Per Unit |
| Sales (350 speakers) .....                             | \$87,500    | \$250    |
| Variable expenses .....                                | 52,500      | 150      |
| Contribution margin .....                              | 35,000      | \$100    |
| Fixed expenses .....                                   | 35,000      |          |
| Net operating income .....                             | <u>\$ 0</u> |          |

Computation of the break-even point is discussed in detail later in the chapter; for the moment, note that the **break-even point** is the level of sales at which profit is zero. Once the break-even

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point has been reached, net operating income will increase by the amount of the unit contribution margin for each additional unit sold. For example, if 351 speakers are sold in a month, then the net operating income for the month will be \$100, since the company will have sold 1 speaker more than the number needed to break even:

| Contribution Income Statement<br>Sales of 351 Speakers |               |          |
|--|---------------|----------|
|  | Total         | Per Unit |
| Sales (351 speakers) .....                             | \$87,750      | \$250    |
| Variable expenses .....                                | 52,650        | 150      |
| Contribution margin .....                              | 35,100        | \$100    |
| Fixed expenses .....                                   | 35,000        |          |
| Net operating income .....                             | <u>\$ 100</u> |          |

If 352 speakers are sold (2 speakers above the break-even point), the net operating income for the month will be \$200. If 353 speakers are sold (3 speakers above the break-even point), the net operating income for the month will be \$300, and so forth. To estimate the profit at any sales volume above the break-even point, simply multiply the number of units sold in excess of the break-even point by the unit contribution margin. The result represents the anticipated profits for the period. Or, to estimate the effect of a planned increase in sales on profits, simply multiply the increase in units sold by the unit contribution margin. The result will be the expected increase in profits. To illustrate, if Acoustic Concepts is currently selling 400 speakers per month and plans to increase sales to 425 speakers per month, the anticipated impact on profits can be computed as follows:

|   |                |
|---|----------------|
| Increased number of speakers to be sold ..... | 25             |
| Contribution margin per speaker .....         | × \$100        |
| Increase in net operating income .....        | <u>\$2,500</u> |

These calculations can be verified as follows:

|  | Sales Volume    |                 | Difference<br>(25 Speakers) | Per Unit |
|--|-----------------|-----------------|-----------------------------|----------|
|  | 400<br>Speakers | 425<br>Speakers |                             |          |
| Sales (@ \$250 per speaker) .....                | \$100,000       | \$106,250       | \$6,250                     | \$250    |
| Variable expenses<br>(@ \$150 per speaker) ..... | 60,000          | 63,750          | 3,750                       | 150      |
| Contribution margin .....                        | 40,000          | 42,500          | 2,500                       | \$100    |
| Fixed expenses .....                             | 35,000          | 35,000          | 0                           |          |
| Net operating income .....                       | <u>\$ 5,000</u> | <u>\$ 7,500</u> | <u>\$2,500</u>              |          |

To summarize, if sales are zero, the company's loss would equal its fixed expenses. Each unit that is sold reduces the loss by the amount of the unit contribution margin. Once the break-even point has been reached, each additional unit sold increases the company's profit by the amount of the unit contribution margin.

### Contribution Margin Ratio:

Contribution margin ratio (CM ratio) is the ratio of contribution margin to net sales. It tells what percentage of sales revenue is available to cover fixed cost and generate profit. In the previous section, we explored how cost-volume-profit relationships can be visualized. In this section, we show how the contribution margin ratio can be used in cost-volume-profit calculations. As the first step, we have added a column to Acoustic Concepts' contribution format income statement in which sales revenues, variable expenses, and contribution margin are expressed as a percentage of sales:

#### Formula:

Contribution margin ratio is calculated by dividing contribution margin figure by the net sales figure. The formula can be written as follows:

$$\text{Contribution margin ratio} = \frac{\text{Contribution margin}}{\text{Net sales}}$$

The ratio is also shown in percentage form as follows:

$$\text{Contribution margin percentage} = \frac{\text{Contribution margin}}{\text{Net sales}} \times 100$$

|                            | Total     | Per Unit | Percent of Sales |
|----------------------------|-----------|----------|------------------|
| Sales (400 speakers) ..... | \$100,000 | \$250    | 100%             |
| Variable expenses .....    | 60,000    | 150      | 60%              |
| Contribution margin .....  | 40,000    | \$100    | 40%              |
| Fixed expenses .....       | 35,000    |          |                  |
| Net operating income ..... | \$ 5,000  |          |                  |

The contribution margin as a percentage of sales is referred to as the **contribution margin ratio (CM ratio)**. This ratio is computed as follows:

$$\text{CM ratio} = \frac{\text{Contribution margin}}{\text{Sales}}$$

For Acoustic Concepts, the computations are:

$$\text{CM ratio} = \frac{\text{Total contribution margin}}{\text{Total sales}} = \frac{\$40,000}{\$100,000} = 40\%$$

In a company such as Acoustic Concepts that has only one product, the CM ratio can also be computed on a per unit basis as follows:

$$\text{CM ratio} = \frac{\text{Unit contribution margin}}{\text{Unit selling price}} = \frac{\$100}{\$250} = 40\%$$

The CM ratio shows how the contribution margin will be affected by a change in total sales. Acoustic Concepts' CM ratio of 40% means that for each dollar increase in sales, total contribution margin will increase by 40 cents (\$1 sales × CM ratio of 40%). Net operating income will also increase by 40 cents, assuming that fixed costs are not affected by the increase in sales. As this illustration suggests, the impact on net operating income of any given dollar change in total sales can be computed by simply applying the CM ratio to the dollar change. For example, if Acoustic Concepts plans a \$30,000 increase in sales during the coming month, the contribution margin should increase by \$12,000 (\$30,000 increase in sales × CM ratio of 40%). As we noted above, net operating income will also increase by \$12,000 if fixed costs do not change. This is verified by the following table:

|   | Sales Volume |           |          | Percent of Sales |
|---|--------------|-----------|----------|------------------|
|   | Present      | Expected  | Increase |                  |
| Sales .....   | \$100,000    | \$130,000 | \$30,000 | 100%             |
| Variable expenses .....   | 60,000       | 78,000*   | 18,000   | 60%              |
| Contribution margin .....   | 40,000       | 52,000    | 12,000   | 40%              |
| Fixed expenses .....  | 35,000       | 35,000    | 0        |                  |
| Net operating income .....  | \$ 5,000     | \$ 17,000 | \$12,000 |                  |
| * \$130,000 expected sales ÷ \$250 per unit = 520 units. 520 units × \$150 per unit = \$78,000. |              |           |          |                  |

The CM ratio is particularly valuable in situations where the dollar sales of one product must be traded off against the dollar sales of another product. In this situation, Cost-Volume-Profit Relationships products that yield the greatest amount of contribution margin per dollar of sales should be emphasized.

### 3.5: Break-Even Analysis:

A break-even analysis is a financial tool which helps you to determine at what stage your company, or a new service or a product, will be profitable. In other words, it's a financial calculation for determining the number of products or services a company should sell to cover its costs (particularly fixed costs). Break-even is a situation where you are neither making money nor losing money, but all your costs have been covered. Break-even analysis is useful in studying the relation between the variable cost, fixed cost and revenue. Generally, a company with low fixed costs will have a low break-even point of sale. For an example, a company has a fixed cost of Rs.0 (zero) will automatically have broken even upon the first sale of its product.

#### Components of Break Even Analysis:

##### Fixed costs

Fixed costs are also called as the overhead cost. These overhead costs occur after the decision to start an economic activity is taken and these costs are directly related to the level of production, but not the quantity of production. Fixed costs include (but are not limited to) interest, taxes, salaries, rent, depreciation costs, labour costs, energy costs etc. These costs are fixed no matter how much you sell.

##### Variable costs

Variable costs are costs that will increase or decrease in direct relation to the production volume. These cost include cost of raw material, packaging cost, fuel and other costs that are directly related to the production.

#### Breakeven analysis is useful for the following reasons:

- It helps to determine remaining/unused capacity of the concern once the breakeven is reached. This will help to show the maximum profit on a particular product/service that can be generated.
- It helps to determine the impact on profit on changing to automation from manual (a fixed cost replaces a variable cost).
- It helps to determine the change in profits if the price of a product is altered.
- It helps to determine the amount of losses that could be sustained if there is a sales downturn.

#### Calculation of Break-Even Analysis

The break-even point can be computed using either the equation method or the contribution margin method - the two methods are equivalent.

**a. The Equation Method:** The **equation method** translates the contribution format income statement illustrated earlier in the chapter into equation form as follows:

$$\text{Profits} = (\text{Sales} - \text{Variable expenses}) - \text{Fixed expenses}$$

Rearranging this equation slightly yields the following equation, which is widely used in CVP analysis:

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

At the break-even point, profits are zero. Therefore, the break-even point can be computed by finding the point where sales equal the total of the variable expenses plus the fixed expenses. For Acoustic Concepts, the break-even point in unit sales,  $Q$ , can be computed as follows:

$$\begin{aligned} \text{Sales} &= \text{Variable expenses} + \text{Fixed expenses} + \text{Profits} \\ \$250Q &= \$150Q + \$35,000 + \$0 \\ \$100Q &= \$35,000 \\ Q &= \$35,000 \div \$100 \text{ per speaker} \\ Q &= 350 \text{ speakers} \end{aligned}$$

Where:

- $Q$  = Quantity of speakers sold
- $\$250$  = Unit selling price
- $\$150$  = Unit variable expenses
- $\$35,000$  = Total fixed expenses

The break-even point in total sales dollars can be computed by multiplying the breakeven level of unit sales by the selling price per unit:

$$350 \text{ speakers} = \$250 \text{ per speaker} \times 350 \text{ speakers} = \$87,500$$

The break-even point in total sales dollars,  $X$ , can also be computed as follows:

$$\begin{aligned} \text{Sales} &= \text{Variable expenses} + \text{Fixed expenses} + \text{Profits} \\ X &= 0.60 X + \$35,000 + \$0 \\ 0.40 X &= \$35,000 \\ X &= \$35,000 \div 0.40 \\ X &= \$87,500 \end{aligned}$$

Where:

- $X$  = Total sales dollars
- $0.60$  = Variable expense ratio (Variable expenses  $\div$  Sales)
- $\$35,000$  = Total fixed expenses

Note that in the above analysis the *variable expense ratio* is used. The **variable expense ratio** is the ratio of variable expense to sales. It can be computed by dividing the total variable expense by the total sales, or in a single product analysis, it can be computed by dividing the variable cost per unit by the unit selling price. Also note that the use of the ratios in the above analysis yields a break-even point expressed in sales dollars rather than in units sold. If desired, the break-even point in units sold can be computed as follows:

$$\$87,500 = \$250 \text{ per speaker} \times 350 \text{ speakers}$$



**b. The Contribution Margin Method:** The **contribution margin method** is a shortcut version of the equation method already described. The approach centers on the idea discussed earlier that each unit sold provides a certain amount of contribution margin that goes toward covering fixed costs. To find how many units must be sold to break even, divide the total fixed expenses by the unit contribution margin:

$$\text{Break - even point in units sold} = \text{Fixed expenses} \div \text{Unit contribution margin}$$

Each speaker generates a contribution margin of \$100 (\$250 selling price, less \$150 variable expenses). Since the total fixed expenses are \$35,000, the break-even point in unit sales is computed as follows:

$$\text{Fixed expenses} \div \text{Unit contribution margin} = \$35,000 \div \$100 \text{ per speaker} = 350 \text{ speakers}$$

A variation of this method uses the CM ratio instead of the unit contribution margin. The result is the break-even point in total sales dollars rather than in total units sold.

$$\text{Break - even point in total sales dollars} = \text{Fixed expenses} \div \text{CM ratio}$$

In the Acoustic Concepts example, the calculation is as follows:

$$\text{Fixed expenses} \div \text{CM ratio} = \$35,000 \div 0.40 = \$87,500$$

This approach, based on the CM ratio, is particularly useful when a company has multiple products and wishes to compute a single break- even point for the company as a whole.

### 3.6: Target Profit Analysis:

CVP formulas can be used to determine the sales volume needed to achieve a target profit. Suppose that Prem Narayan of Acoustic Concepts wishes to earn a target profit of \$40,000 per month. How many speakers would have to be sold?

**The CVP Equation:** One approach is to use the equation method. Instead of solving for the unit sales where profits are zero, solve for the unit sales where profits are \$40,000.

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

$$\$250Q = \$150Q + \$35,000 + \$40,000$$

$$\$100Q = \$75,000$$

$$Q = \$75,000 \div \$100 \text{ per speaker}$$

$$Q = 750 \text{ speakers}$$

Where:

$$Q = \text{Quantity of speakers sold}$$

$$\$250 = \text{Unit selling price}$$

$$\$150 = \text{Unit variable expenses}$$

$$\$35,000 = \text{Total fixed expenses}$$

$$\$40,000 = \text{Target profit}$$

Thus, the target profit can be achieved by selling 750 speakers per month, which represents \$187,500 in total sales (\$250 per speaker  $\times$  750 speakers).

**The Contribution Margin Approach:** A second approach involves expanding the contribution margin formula to include the target profit:

$$\begin{aligned}\text{Unit sales to attain the target profit} &= (\text{Fixed expenses} + \text{Target profit}) \div \text{Unit contribution margin} \\ &= (\$35,000 + \$40,000) \div \$100 \text{ per speaker} \\ &= 750 \text{ speakers}\end{aligned}$$

This approach gives the same answer as the equation method because it is simply a shortcut version of the equation method. Similarly, the dollar sales needed to attain the target profit can be computed as follows:

$$\begin{aligned}\text{Dollar sales to attain target profit} &= (\text{Fixed expenses} + \text{Target profit}) \div \text{CM ratio} \\ &= (\$35,000 + \$40,000) \div 0.40 \\ &= \$187,500\end{aligned}$$

### 3.7: The Margin of Safety:

The **margin of safety** is the excess of budgeted (or actual) sales dollars over the break-even volume of sales dollars. It is the amount by which sales can drop before losses are incurred. The higher the margin of safety, the lower the risk of not breaking even and incurring a loss. The formula for its calculation is:

$$\text{Margin of safety} = \text{Total budgeted (or actual) sales} \div \text{Break - even sales}$$

The margin of safety can also be expressed in percentage form by dividing the margin of safety in dollars by total dollar sales:

$$\text{Margin of safety percentage} = \text{Margin of safety in dollars} \div \text{Total budgeted (or actual) sales in dollars}$$

The calculation of the margin of safety for Acoustic Concepts is:

|  |                  |
|--|------------------|
| Sales (at the current volume of 400 speakers) (a) . . . . .    | \$100,000        |
| Break-even sales (at 350 speakers). . . . .                    | 87,500           |
| Margin of safety (in dollars) (b). . . . .                     | <u>\$ 12,500</u> |
| Margin of safety as a percentage of sales, (b) ÷ (a) . . . . . | <u>12.5%</u>     |

### 3.8: Operating Leverage:

A lever is a tool for multiplying force. Using a lever, a massive object can be moved with only a modest amount of force. In business, operating leverage serves a similar purpose.

**Operating leverage** is a measure of how sensitive net operating income is to a given percentage change in dollar sales. Operating leverage acts as a multiplier. If operating leverage is high, a small percentage increase in sales can produce a much larger percentage increase in net operating income. Operating leverage can be illustrated by returning to the data for the two blueberry farms. We previously showed that a 10% increase in sales (from \$100,000 to \$110,000 in each farm) results in a 70% increase in the net operating income of Sterling Farm (from \$10,000 to \$17,000) and only a 40% increase in the net operating income of Bogside Farm (from \$10,000 to

\$14,000). Thus, for a 10% increase in sales, Sterling Farm experiences a much greater percentage increase in profits than does Bogside Farm. Therefore, Sterling Farm has greater operating leverage than Bogside Farm. The **degree of operating leverage** at a given level of sales is computed by the following formula:

$$\text{Degree of operating leverage} = \text{Contribution margin} \div \text{Net operating income}$$

The degree of operating leverage is a measure, at a given level of sales, of how a percentage change in sales volume will affect profits. To illustrate, the degree of operating leverage for the two farms at \$100,000 sales would be computed as follows:

$$\text{Bogside Farm} = \$40,000 \div \$10,000 = 4$$

$$\text{Sterling Farm} = \$70,000 \div \$10,000 = 7$$

Since the degree of operating leverage for Bogside Farm is 4, the farm's net operating income grows four times as fast as its sales. Similarly, Sterling Farm's net operating income grows seven times as fast as its sales. Thus, if sales increase by 10%, then we can expect the net operating income of Bogside Farm to increase by four times this amount, or by 40%, and the net operating income of Sterling Farm to increase by seven times this amount, or by 70%.

|                         | (1)                       | (2)                          | Percent Increase in Net Operating Income (1) × (2) |
|-------------------------|---------------------------|------------------------------|--|
|                         | Percent Increase in Sales | Degree of Operating Leverage |  |
| Bogside Farm . . . . .  | 10%                       | 4                            | 40%  |
| Sterling Farm . . . . . | 10%                       | 7                            | 70%  |

### 3.9: Summary:

CVP analysis is based on a simple model of how profits respond to prices, costs, and volume. This model can be used to answer a variety of critical questions such as what is the company's break-even volume, what is its margin of safety, and what is likely to happen if specific changes are made in prices, costs, and volume.

A CVP graph depicts the relationships between sales volume in units on the one hand and fixed expenses, variable expenses, total expenses, total sales, and profits on the other hand. The CVP graph is useful for developing intuition about how costs and profits respond to changes in sales volume. The contribution margin ratio is the ratio of the total contribution margin to total sales. This ratio can be used to quickly estimate what impact a change in total sales would have on net operating income. The ratio is also useful in break-even analysis.

The break-even point is the level of sales (in units or in dollars) at which the company just breaks even. The break-even point can be computed using several different techniques that are all based on the simple CVP model. With slight modifications, the same techniques can be used to compute the level of sales required to attain a target profit. The margin of safety is the amount by which the company's current sales exceeds break-even sales.

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The degree of operating leverage allows quick estimation of what impact a given percentage change in sales would have on the company's net operating income. The higher the degree of operating leverage, the greater is the impact on the company's profits. The degree of operating leverage is not constant - it depends on the company's current level of sales.

The profits of a multiproduct company are affected by its sales mix. Changes in the sales mix can affect the break-even point, margin of safety, and other critical factors.

**EXERCISE****Exc-01: Review Problem: CVP Relationships**

Voltar Company manufactures and sells a specialized cordless telephone for high electromagnetic radiation environments. The company's contribution format income statement for the most recent year is given below:

|                            | Total       | Per Unit | Percent of Sales |
|----------------------------|-------------|----------|------------------|
| Sales (20,000 units) ..... | \$1,200,000 | \$60     | 100%             |
| Variable expenses .....    | 900,000     | 45       | ? %              |
| Contribution margin .....  | 300,000     | \$15     | ? %              |
| Fixed expenses .....       | 240,000     |          |                  |
| Net operating income ..... | \$ 60,000   |          |                  |

Management is anxious to increase the company's profit and has asked for an analysis of a number of items.

**Required:**

- a. Compute the company's CM ratio and variable expense ratio.
- b. Compute the company's break-even point in both units and sales dollars. Use the equation method.
- c. Assume that sales increase by \$400,000 next year. If cost behavior patterns remain unchanged, by how much will the company's net operating income increase? Use the CM ratio to compute your answer.
- d. Refer to the original data. Assume that next year management wants the company to earn a profit of at least \$90,000. How many units will have to be sold to meet this target profit?
- e. Refer to the original data. Compute the company's margin of safety in both dollar and percentage form.
- f.
  - i. Compute the company's degree of operating leverage at the present level of sales.
  - ii. Assume that through a more intense effort by the sales staff, the company's sales increase by 8% next year. By what percentage would you expect net operating income to increase? Use the degree of operating leverage to obtain your answer.
  - iii. Verify your answer to (ii) by preparing a new contribution format income statement showing an 8% increase in sales.

- g. In an effort to increase sales and profits, management is considering the use of a higher-quality speaker. The higher-quality speaker would increase variable costs by \$3 per unit, but management could eliminate one quality inspector who is paid a salary of \$30,000 per year. The sales manager estimates that the higher-quality speaker would increase annual sales by at least 20%.
- i. Assuming that changes are made as described above, prepare a projected contribution format income statement for next year. Show data on a total, per unit, and percentage basis.
- ii. Compute the company's new break-even point in both units and dollars of sales. Use the contribution margin method.
- iii. Would you recommend that the changes be made?

**Solution:**

a)

$$\text{CM ratio} = \frac{\text{Unit contribution margin}}{\text{Selling price}} = \frac{\$15}{\$60} = 25\%$$

$$\text{Variable expense ratio} = \frac{\text{Variable expense}}{\text{Selling price}} = \frac{\$45}{\$60} = 75\%$$

b)

$$\begin{aligned}\text{Sales} &= \text{Variable expenses} + \text{Fixed expenses} + \text{Profits} \\ \$60Q &= \$45Q + \$240,000 + \$0 \\ \$15Q &= \$240,000 \\ Q &= \$240,000 \div \$15 \text{ per unit} \\ Q &= 16,000 \text{ units; or at } \$60 \text{ per unit, } \$960,000\end{aligned}$$

**Alternative:**

$$\begin{aligned}X &= 0.75X + \$240,000 + \$0 \\ 0.25X &= \$240,000 \\ X &= \$240,000 \div 0.25 \\ X &= \$960,000; \text{ or at } \$60 \text{ per unit, } 16,000 \text{ units}\end{aligned}$$

c)

|  |                  |
|--|------------------|
| Increase in sales .....                        | \$400,000        |
| Multiply by the CM ratio .....                 | × 25%            |
| Expected increase in contribution margin ..... | <u>\$100,000</u> |

Since the fixed expenses are not expected to change, net operating income will increase by the entire \$100,000 increase in contribution margin computed above.

d)

Equation method:

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

$$\$60Q = \$45Q + \$240,000 + \$90,000$$

$$\$15Q = \$330,000$$

$$Q = \$330,000 \div \$15 \text{ per unit}$$

$$Q = 22,000 \text{ units}$$

Contribution margin method:

$$\frac{\text{Fixed expenses} + \text{Target profit}}{\text{Contribution margin per unit}} = \frac{\$240,000 + \$90,000}{\$15 \text{ per unit}} = 22,000 \text{ units}$$

e)

$$\text{Margin of safety in dollars} = \text{Total sales} - \text{Break-even sales}$$

$$= \$1,200,000 - \$960,000 = \$240,000$$

$$\text{Margin of safety percentage} = \frac{\text{Margin of safety in dollars}}{\text{Total sales}} = \frac{\$240,000}{\$1,200,000} = 20\%$$

f)

i.

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Net operating income}} = \frac{\$300,000}{\$60,000} = 5$$

ii.

|   |                   |
|---|-------------------|
| Expected increase in sales .....                | 8%                |
| Degree of operating leverage .....              | <u>× 5</u>        |
| Expected increase in net operating income ..... | <u><u>40%</u></u> |

iii.

- c. If sales increase by 8%, then 21,600 units ( $20,000 \times 1.08 = 21,600$ ) will be sold next year. The new contribution format income statement would be as follows:

|                            | Total                   | Per Unit    | Percent of Sales |
|----------------------------|-------------------------|-------------|------------------|
| Sales (21,600 units) ..... | \$1,296,000             | \$60        | 100%             |
| Variable expenses .....    | <u>972,000</u>          | <u>45</u>   | <u>75%</u>       |
| Contribution margin .....  | 324,000                 | <u>\$15</u> | <u>25%</u>       |
| Fixed expenses .....       | <u>240,000</u>          |             |                  |
| Net operating income ..... | <u><u>\$ 84,000</u></u> |             |                  |

Thus, the \$84,000 expected net operating income for next year represents a 40% increase over the \$60,000 net operating income earned during the current year:

$$\frac{\$84,000 - \$60,000}{\$60,000} = \frac{\$24,000}{\$60,000} = 40\% \text{ increase}$$

Note from the income statement above that the increase in sales from 20,000 to 21,600 units has increased *both* total sales and total variable expenses. It is a common error to overlook the increase in variable expenses when preparing a projected contribution format income statement.

g) i.

A 20% increase in sales would result in 24,000 units being sold next year:  $20,000 \text{ units} \times 1.20 = 24,000 \text{ units}$ .

|                            | Total                      | Per Unit    | Percent of Sales |
|----------------------------|----------------------------|-------------|------------------|
| Sales (24,000 units) ..... | \$1,440,000                | \$60        | 100%             |
| Variable expenses .....    | <u>1,152,000</u>           | <u>48*</u>  | <u>80%</u>       |
| Contribution margin .....  | 288,000                    | <u>\$12</u> | <u>20%</u>       |
| Fixed expenses .....       | <u>210,000<sup>†</sup></u> |             |                  |
| Net operating income ..... | <u><u>\$ 78,000</u></u>    |             |                  |

\*\$45 + \$3 = \$48;  $\$48 \div \$60 = 80\%$ .

<sup>†</sup>\$240,000 - \$30,000 = \$210,000.



Note that the change in per unit variable expenses results in a change in both the per unit contribution margin and the CM ratio.

ii.

$$\begin{aligned}\text{Break-even point in unit sales} &= \frac{\text{Fixed expenses}}{\text{Unit contribution margin}} \\ &= \frac{\$210,000}{\$12 \text{ per unit}} = 17,500 \text{ units} \\ \text{Break-even point in dollar sales} &= \frac{\text{Fixed expenses}}{\text{CM ratio}} \\ &= \frac{\$210,000}{0.20} = \$1,050,000\end{aligned}$$

iii.

Yes, based on these data the changes should be made. The changes increase the company's net operating income from the present \$60,000 to \$78,000 per year. Although the changes also result in a higher break-even point (17,500 units as compared to the present 16,000 units), the company's margin of safety actually becomes greater than before:

$$\begin{aligned}\text{Margin of safety in dollars} &= \text{Total sales} - \text{Break-even sales} \\ &= \$1,440,000 - \$1,050,000 = \$390,000\end{aligned}$$

As shown in (e) above, the company's present margin of safety is only \$240,000. Thus, several benefits will result from the proposed changes.

#### Exc-02:

Wheeler Corporation's most recent income statement follows:

|                            | Total           | Per Unit |
|----------------------------|-----------------|----------|
| Sales (8,000 units) .....  | \$208,000       | \$26.00  |
| Variable expenses .....    | 144,000         | 18.00    |
| Contribution margin .....  | 64,000          | \$ 8.00  |
| Fixed expenses .....       | 56,000          |          |
| Net operating income ..... | <u>\$ 8,000</u> |          |

**Required:** Prepare a new contribution format income statement under each of the following conditions (consider each case independently):

- a) The sales volume increases by 50 units.
- b) The sales volume declines by 50 units.
- c) The sales volume is 7,000 units.

**Exc-03:**

Last month when Harrison Creations, Inc., sold 40,000 units, total sales were \$300,000, total variable expenses were \$240,000, and total fixed expenses were \$45,000.

**Required:**

- a) What is the company's contribution margin (CM) ratio?
- b) Estimate the change in the company's net operating income if it were to increase its total sales by \$1,500.

**Exc-04:**

Data for Herron Corporation are shown below:

|                           | Per Unit    | Percent of Sales |
|---------------------------|-------------|------------------|
| Selling price .....       | \$75        | 100%             |
| Variable expenses .....   | 45          | 60%              |
| Contribution margin ..... | <u>\$30</u> | <u>40%</u>       |

Fixed expenses are \$75,000 per month and the company is selling 3,000 units per month.

**Required:**

- a) The marketing manager argues that an \$8,000 increase in the monthly advertising budget would increase monthly sales by \$15,000. Should the advertising budget be increased?
- b) Refer to the original data. Management is considering using higher-quality components that would increase the variable cost by \$3 per unit. The marketing manager believes the higher-quality product would increase sales by 15% per month. Should the higher-quality components be used?

**Exc-05:**

Prime company manufactures and sells a single product. The company's sales and expenses for a recent month follow:

Sales Tk.6,00,000 at Tk.40 per unit.

Total variable costs Tk.4,20,000 and Fixed costs Tk.1,50,000

**Required:**

- a) Compute monthly BEP in units and sales Taka.
- b) How many units would have to be sold to earn a minimum profit target of Tk.42,000.
- c) Find out the margin of safety in both Taka and percentage term.
- d) Compute contribution margin ratio. If sales increases by Tk.80,000 by how much would you expect monthly income to increase?