Chapter 5: Cost-Volume-Profit Analysis

Q1: What is the Cost-Volume-Profit Analysis?
CVP analysis looks at the relationship between cost, Volume and profits to determine the breakeven point.

Q2: What is the breakeven point?
The breakeven point (BEP) is where:
- Total revenue = total costs.
- Net Income = Zero
- Total Contribution Margin = Fixed Cost

Q3: Explain the CVP analysis using graphic form?

Q4: How is CVP Analysis Used?
CVP analysis can determine:
1- Breakeven point both in sales volume and sales dollars.
2- Volume and sales dollars required to achieve target profit.

Break Even Points Formulas

1. \( BEP(U) = \frac{Total\ Fixed\ Costs}{Contribution\ Margin\ Per\ Unit} = \frac{F.C}{C.M/U} = \#\ units \) \( \{C.M/U = SP - V.C/U\} \)

2. \( BEP($) = \frac{Total\ Fixed\ Costs}{Contribution\ Margin\ Ratio} = \frac{F.C}{C.M\%} = \$\# \)

\( C.M\% = \frac{Selling\ Price\ Per\ Unit\ (SP) - Variable\ Cost\ Per\ Unit\ (V.C/U)}{Selling\ Price\ Per\ Unit\ (SP)} \times 100 = \#\% \)

\( C.M\% = \frac{Sales\ Revenue\ (SR) - Variable\ Cost\ (V.C)}{Sales\ Revenue\ (SR)} \times 100 = \#\% \)
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3. Units Required to Earn Profit = \[ \text{Total Fixed Costs + Target Profit \over Contribution Margin Per Unit} = \frac{F.C+Profit}{C.M/U} \]

4. Sales Required to Earn Profit = \[ \text{Total Fixed Costs + Target Profit \over Contribution Margin Ratio} = \frac{F.C+Profit}{C.M\%} \]

5. Safety Margin = \[ \text{Sales (U) - BEP (U)} = \text{Sales ($)} - \text{BEP ($)} \]

6. Safety Margin Ratio = \[ \frac{\text{Sales (U) - BEP (U)}}{\text{Sales (U)}} \]

7. Safety Margin Ratio = \[ \frac{\text{Sales ($)} - \text{BEP ($)}}{\text{Sales ($)}} \]

8. Operating Leverage = \[ \frac{\text{Total Contribution Margin}}{\text{Net Income}} \]

9. Percentage Change in Net Income = Percentage Change in Sales × Operating Leverage

10. Change in Net Income (Contribution Margin) = Change in Sales × CM%

Contribution Format Income Statement:

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Revenue (10,000 units)</td>
<td>100,000</td>
<td>SP/U $10</td>
<td>100%</td>
</tr>
<tr>
<td>(-) Variable Costs</td>
<td>40,000</td>
<td>V.C/U $4</td>
<td>V.C % 40%</td>
</tr>
<tr>
<td>((=)) Total Contribution Margin</td>
<td>60,000</td>
<td>C.M/U $6</td>
<td>C.M% 60%</td>
</tr>
<tr>
<td>(-) Fixed Costs</td>
<td>20,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>((=)) Net Income</td>
<td>40,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Breakeven Point For Multi Products

1. \( \text{BEP (U)} = \frac{\text{Total Fixed Costs}}{\text{Overall Contribution Margin Per Units}} = \frac{\text{F.C}}{\text{Overall C.M/U}} = ## \text{ units} \)

2. \( \text{BEP (S)} = \frac{\text{Total Fixed Costs}}{\text{Overall Contribution Margin Ratio}} = \frac{\text{F.C}}{\text{Overall C.M\%}} = \$ ## \)

3. \( \text{Units Required To Earn Profit} = \frac{\text{Total Fixed Costs} + \text{Profit}}{\text{Overall Units Contribution Margin}} = ## \text{ units} \)

4. \( \text{Sales Required To Earn Profit} = \frac{\text{Total Fixed Costs} + \text{Profit}}{\text{Overall Contribution Margin Ratio}} = \$ ## \)

5. \( \text{Change in Net Income (Contribution Margin)} = \text{Change in Sales} \times \text{Overall CM} \)

Overall Units Contribution Margin

<table>
<thead>
<tr>
<th>Products</th>
<th>S.P/U</th>
<th>V.C/U</th>
<th>C.M/U</th>
<th>Sales Mix</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$10</td>
<td>$4</td>
<td>$6</td>
<td>40%</td>
<td>$2.4</td>
</tr>
<tr>
<td>B</td>
<td>$20</td>
<td>$12</td>
<td>$8</td>
<td>60%</td>
<td>$4.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40%</td>
<td>$7.2</td>
</tr>
</tbody>
</table>

Overall Contribution Margin Ratio

<table>
<thead>
<tr>
<th>Products</th>
<th>S.P/U</th>
<th>V.C/U</th>
<th>C.M</th>
<th>C.M %</th>
<th>Sales Mix</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$10</td>
<td>$4</td>
<td>$6</td>
<td>60%</td>
<td>40%</td>
<td>24%</td>
</tr>
<tr>
<td>B</td>
<td>$20</td>
<td>$12</td>
<td>$8</td>
<td>40%</td>
<td>60%</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Overall Contribution Margin Ratio</td>
<td>48%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$400,000</td>
<td>$600,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>(-) Variable Costs</td>
<td>160,000</td>
<td>360,000</td>
<td>520,000</td>
</tr>
<tr>
<td>(=) Contribution Margin</td>
<td>240,000</td>
<td>240,000</td>
<td>480,000</td>
</tr>
<tr>
<td>(-) Fixed Costs</td>
<td></td>
<td></td>
<td>300,000</td>
</tr>
<tr>
<td>(=) Net Income</td>
<td></td>
<td></td>
<td>180,000</td>
</tr>
</tbody>
</table>
EXERCISE 5–11
Pringle Company distributes a single product. The company’s sales and expenses for a recent month follow:

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$600,000</td>
<td>$40</td>
</tr>
<tr>
<td>Variable expenses</td>
<td>$420,000</td>
<td>$28</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$180,000</td>
<td>$12</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>$150,000</td>
<td></td>
</tr>
<tr>
<td>Net operating income</td>
<td>$30,000</td>
<td></td>
</tr>
</tbody>
</table>

**Required:**
1. What is the monthly break-even point in units sold and in sales dollars?
2. Without resorting to computations, what is the total contribution margin at the break-even point?
3. How many units would have to be sold each month to earn a target profit of $18,000? Use the formula method. Verify your answer by preparing a contribution format income statement at the target level of sales.
4. Refer to the original data. Compute the company’s margin of safety in both dollar and percentage terms.
5. What is the company’s CM ratio? If monthly sales increase by $80,000 and there is no change in fixed expenses, by how much would you expect monthly net operating income to increase?

**Solution**

1. **Break Even Point in Units and Sales Dollars?**

   \[
   \text{BEP (U)} = \frac{\text{Fixed Costs (Expenses)}}{\text{Unit Contribution Margin}} = \frac{\$150,000}{\$12 \text{ per unit}} = 12,500 \text{ units}
   \]

   \[
   \text{BEP ($)} = \frac{\text{Fixed Costs (Expenses)}}{\text{Contribution Margin Ratio}} = \frac{\$150,000}{30\%} = \$500,000
   \]

   Contribution Margin Ratio = \frac{\text{Contribution Margin per unit}}{\text{Selling Price per Unit}} \times 100

   Contribution Margin Ratio = \frac{\$12}{\$40} \times 100 = 30\%

2. **Without resorting to computations, what is the total contribution margin at the break-even point?**

   The contribution margin at the break-even point is $150,000 because at that point it must equal the fixed expenses.
3. How many units would have to be sold each month to earn a target profit of $18,000? Use the formula method. Verify your answer by preparing a contribution format income statement at the target level of sales.

Units Sold to attain target profit = \( \frac{Fixed\ Costs + Target\ Profit}{Unit\ Contribution\ Margin} \)

Units Sold to attain target profit = \( \frac{\$150,000 + \$18,000}{\$12\ Per\ Unit} \) = 14,000 units

Verifying our answer:

<table>
<thead>
<tr>
<th>Total</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (14,000 units \times $40 per unit) ..........</td>
<td>$560,000</td>
</tr>
<tr>
<td>(-) Variable expenses (14,000 units \times $28)</td>
<td>392,000</td>
</tr>
<tr>
<td>(=) Contribution margin</td>
<td>168,000</td>
</tr>
<tr>
<td>(-) Fixed expenses.........................</td>
<td>150,000</td>
</tr>
<tr>
<td>(=) Net operating income .......................</td>
<td>$ 18,000</td>
</tr>
</tbody>
</table>

4. Refer to the original data. Compute the company’s margin of safety in both dollar and percentage terms.

Margin of Safety in Dollars = Sales revenue – BEP($)
= \$600,000 - \$500,000
= \$100,000

Margin of Safety in Percentage = \( \frac{\$600,000 - \$500,000}{\$600,000} \times 100 = 16.67\% \)

5. What is the company’s CM ratio? If monthly sales increase by \$80,000 and there is no change in fixed expenses, by how much would you expect monthly net operating income to increase?

a) Contribution Margin Ratio = \( \frac{Contribution\ Margin\ per\ unit}{Selling\ Price\ per\ Unit} \times 100 \)

Contribution Margin Ratio = \( \frac{\$12}{\$40} \times 100 = 30\% \)

b) Change in Net Income (Increase) = Change in Sales \times Contribution margin ratio
Change in Net Income (Increase) = \$80,000 \times 30\% = \$24,000
EXERCISE 5–14
Okabee Enterprises is the distributor for two products, Model A100 and Model B900. Monthly sales and the contribution margin ratios for the two products follow:

<table>
<thead>
<tr>
<th>Sales (1)</th>
<th>Model A100</th>
<th>Model B900</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$700,000</td>
<td>$300,000</td>
<td>$1,000,000</td>
<td></td>
</tr>
<tr>
<td>Contribution margin ratio (2)</td>
<td>60%</td>
<td>70%</td>
<td>?</td>
</tr>
</tbody>
</table>

The company’s fixed expenses total $598,500 per month.

**Required:**
1. Prepare a contribution format income statement for the company as a whole.
2. Compute the break-even point for the company based on the current sales mix.
3. If sales increase by $50,000 per month, by how much would you expect net operating income to increase? What are your assumptions?

**Solution:**

1. Prepare a contribution format income statement for the company as a whole.

<table>
<thead>
<tr>
<th>Sales (1)</th>
<th>Model A100</th>
<th>Model B900</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$700,000</td>
<td>$300,000</td>
<td>$1,000,000</td>
<td></td>
</tr>
<tr>
<td>Variable expenses (3)</td>
<td>$280,000</td>
<td>$90,000</td>
<td>$370,000</td>
</tr>
<tr>
<td>Contribution Margin (2)</td>
<td>420,000</td>
<td>210,000</td>
<td>630,000</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>$700,000×60%</td>
<td>$300,000×70%</td>
<td>$598,500</td>
</tr>
<tr>
<td>Net Income</td>
<td>$31,500</td>
<td></td>
<td>$31,500</td>
</tr>
</tbody>
</table>

2. Compute the break-even point for the company based on the current sales mix.

   \[
   \text{PEP ($)} = \frac{\text{Fixed Costs}}{\text{Overall Contribution margin ratio}}
   \]

   \[
   \text{PEP ($)} = \frac{598,500}{0.63} = 950,000
   \]

   Overall Contribution margin ratio = \[
   \frac{\text{Total Contribution Margin}}{\text{Total Sales revenue}}
   \]

   Overall Contribution margin ratio = \[
   \frac{630,000}{1,000,000} \times 100 = 63\%
   \]

3. Increase in Net Income = Increase in Sales \times Overall Contribution margin

   = $50,000 \times 63\% = $31,500
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PROBLEM 5–20
Memofax, Inc., produces memory enhancement kits for fax machines. Sales have been very erratic, with some months showing a profit and some months showing a loss. The company’s contribution format income statement for the most recent month is given below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (13,500 units at $20 per unit)</td>
<td>$270,000</td>
</tr>
<tr>
<td>Variable expenses</td>
<td>$189,000</td>
</tr>
<tr>
<td>Contribution margin</td>
<td>$81,000</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>$90,000</td>
</tr>
<tr>
<td>Net operating loss</td>
<td>$(9,000)</td>
</tr>
</tbody>
</table>

**Required:**

1. Compute the company’s CM ratio and its break-even point in both units and dollars.
2. The sales manager feels that an $8,000 increase in the monthly advertising budget, combined with an intensified effort by the sales staff, will result in a $70,000 increase in monthly sales. If the sales manager is right, what will be the effect on the company’s monthly net operating income or loss? (Use the incremental approach in preparing your answer.)

3. Refer to the original data. The president is convinced that a 10% reduction in the selling price, combined with an increase of $35,000 in the monthly advertising budget, will double unit sales. What will the new contribution format income statement look like if these changes are adopted?

4. Refer to the original data. The company’s advertising agency thinks that a new package would help sales. The new package being proposed would increase packaging costs by $0.60 per unit. Assuming no other changes, how many units would have to be sold each month to earn a profit of $4,500?

5. Refer to the original data. By automating, the company could slash its variable expenses in half. However, fixed costs would increase by $118,000 per month.
   a. Compute the new CM ratio and the new break-even point in both units and dollars.
   b. Assume that the company expects to sell 20,000 units next month. Prepare two contribution format income statements, one assuming that operations are not automated and one assuming that they are.
   c. Would you recommend that the company automate its operations? Explain.
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Solution:

1. Compute the company’s CM ratio and its break-even point in both units and dollars.

\[
C.M\% = \frac{Sales\ Revenue\ (SR) - Variable\ Cost\ (V.C)}{Sales\ Revenue\ (SR)} \times 100
\]

\[
C.M\% = \frac{270,000 - 189,000}{270,000} \times 100 = 30\%
\]

\[
BEP\ (U) = \frac{Fixed\ Costs\ (Expenses)}{Unit\ Contribution\ Margin} = \frac{90,000}{$6\ per\ unit} = 15,000\ units
\]

\[
BEP\ ($) = \frac{Fixed\ Costs\ (Expenses)}{Contribution\ Margin\ Ratio} = \frac{90,000}{30\%} = $300,000
\]

2. The sales manager feels that an $8,000 increase in the monthly advertising budget, combined with an intensified effort by the sales staff, will result in a $70,000 increase in monthly sales. If the sales manager is right, what will be the effect on the company’s monthly net operating income or loss? (Use the incremental approach in preparing your answer.)

\[
\text{Increase in contribution margin} = 70,000 \times 30\% = 21,000
\]

\[
\text{Increase in advertising cost} = 8,000
\]

\[
\text{= Change in net income (increase)} = 13,000
\]

3. Refer to the original data. The president is convinced that a 10% reduction in the selling price, combined with an increase of $35,000 in the monthly advertising budget, will double unit sales. What will the new contribution format income statement look like if these changes are adopted?

\[
\begin{array}{l}
\text{Sales} = [13,500 \times 2] \times [20 \times 90\%] = 486,000 \\
\text{(-) variable expenses} = [13,500 \times 2] \times 14 = 378,000 \\
\text{= Contribution margin} = 108,000 \\
\text{(-) Fixed costs} = 90,000 + 35,000 = 125,000 \\
\text{= Net Loss} = -17,000
\end{array}
\]

4. Refer to the original data. The company’s advertising agency thinks that a new package would help sales. The new package being proposed would increase packaging costs by $0.60 per unit. Assuming no other changes, how many units would have to be sold each month to earn a profit of $4,500?

\[
\text{Units Required to Earn Profit} = \frac{\text{Total Fixed Costs + Target Profit}}{\text{Contribution Margin Per Unit}}
\]

\[
= \frac{90,000 + 4,500}{20 - 14.6} = 17,500\ units
\]
Chapter 5: Cost-Volume-Profit Analysis

5. Refer to the original data. By automating, the company could slash its variable expenses in half. However, fixed costs would increase by $118,000 per month.
   a. Compute the new CM ratio and the new break-even point in both units and dollars.

   
   \[ C.M\% = \frac{270,000 - 94,500}{270,000} \times 100 = 65\% \]
   
   \[ \text{BEP (U)} = \frac{\text{Fixed Costs (Expenses)}}{\text{Unit Contribution Margin}} = \frac{208,000}{20 - 7} = 16,000 \text{ units} \]
   
   \[ \text{BEP (\$)} = \frac{\text{Fixed Costs (Expenses)}}{\text{Contribution Margin Ratio}} = \frac{208,000}{65\%} = \$320,000 \]

   b. Assume that the company expects to sell 20,000 units next month. Prepare two contribution format income statements, one assuming that operations are not automated and one assuming that they are.

   | Sales (20,000 × $20) | $400,000 |
   | (-) variable expenses (20,000 × $14) | 280,000 |
   | = Contribution margin | 120,000 |
   | (-) Fixed costs [90,000] | 90,000 |
   | = Net Income | 30,000 |

   | Sales (20,000 × $20) | $400,000 |
   | (-) variable expenses (20,000 × $7) | 140,000 |
   | = Contribution margin | 260,000 |
   | (-) Fixed costs [90,000 + 118,000] | 208,000 |
   | = Net Income | 52,000 |

   c. Would you recommend that the company automate its operations? Explain.