

AC 202 Management Accounting

- *Cost-Volume-Profit Relationships*
- *Differential Analysis*

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Course Objectives

- Managerial Accounting (Garrison et. al, 2015)
 - Chapter 4: Cost-Volume-Profit Relationships
 - Chapter 14: Differential Analysis
- After studying both chapters, you should be able to:
 - Determine the break-even point for both a single product company and a multiproduct company.
 - Determine the level of sales needed to attain a target profit.
 - Perform sensitivity analysis.
 - Compute the margin of safety and explain its significance.
 - Identify relevant and irrelevant costs and benefits in a decision.
 - Make a decision using relevant information concept.

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Cost-Volume-Profit (CVP) Analysis

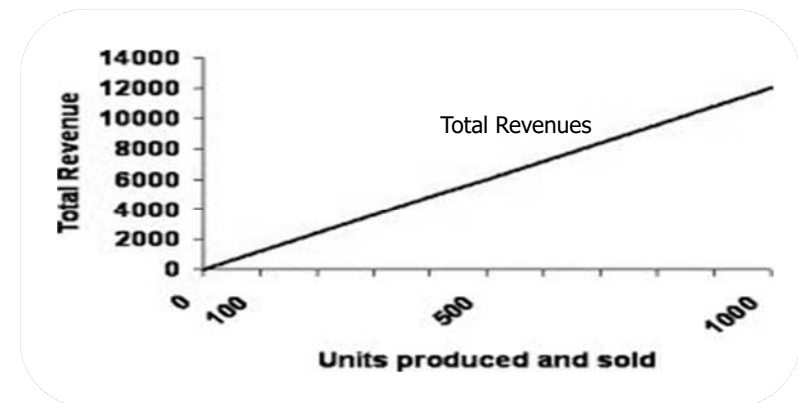
- CVP analysis is a technique that examines changes in profits in response to changes in sales volumes, costs, and prices.
- CVP analysis is used to answer questions such as:
 - How much must I sell to earn my desired income?
 - How will income be affected if I reduce selling prices to increase sales volume?
 - What will happen to profitability if I expand capacity?



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CVP Basic Assumptions

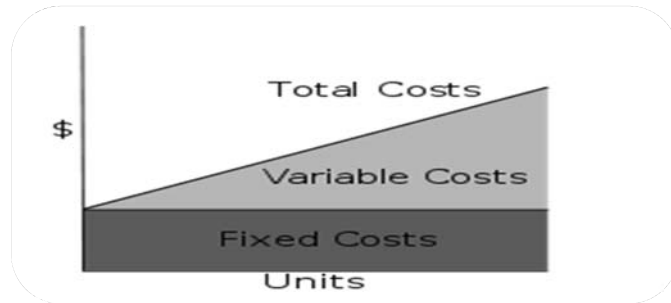
- 1 The unit selling price is known and constant. Therefore, revenues are linear (*straight-line*).



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CVP Basic Assumptions

- ② The unit variable costs, and fixed costs are known and constant. Costs are linear (*straight-line*) and costs can be accurately divided into variable (constant per unit) and fixed (constant in total) elements.



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CVP Basic Assumptions

- ③ In multiproduct companies, the *sales mix* is constant as the level of total units sold changes.
- ④ In manufacturing companies, inventories do not change (units produced = units sold).

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Contribution Margin Income Statement

From Assumption ②

- ❖ Revenues
- ❖ Less: Variable Costs
- ❖ Contribution Margin
- ❖ Less: Fixed Costs
- ❖ Operating Income

Contribution margin per unit (CMU) tells us how much revenue from each unit sold can be applied toward fixed costs. Once enough units have been sold to cover all fixed costs, then the CMU from all remaining sales becomes profit.

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Profit Equation and Contribution Margin

■ **Contribution Margin (CM)**

$$CM = \text{Total revenues} - \text{Total variable costs}$$

■ **Contribution Margin per Unit (CMU)**

$$CMU = \text{Unit selling price} - \text{Variable cost per unit}$$

■ **Contribution Margin Ratio (percentage)**

$$CM\% = CMU \div \text{Unit selling price}$$

$$\text{Or } CM\% = \text{Total CM} \div \text{Total Revenues}$$

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Quick Check ✓



Coffee Go is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the contribution margin per unit for Coffee Go?

- a. \$1.13
- b. \$1.49
- c. \$0.36
- d. \$1.85

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Quick Check ✓



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- a. 131.9%
- b. 75.8%
- c. 24.2%
- d. 413.9%

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Break-even Point

- The break-even point (expressed in units of product or dollars of sales) is the unique sales level at which a company ***earns neither a profit nor incurs a loss.***

$$\text{Total revenues} = \text{Total costs}$$

$$\text{Total revenues} - \text{Total costs} = 0$$

$$\text{Total revenues} - \text{Total variable costs} - \text{Total fixed costs} = 0$$

$$\text{Total revenues} - \text{Total variable costs} = \text{Total fixed costs}$$

$$\text{Total contribution margin} = \text{Total fixed costs}$$

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Computing Break-Even Point

	Total	Unit
Sales Revenue (2,000 units)	\$ 100,000	\$ 50
Less: Variable costs	60,000	30
Contribution margin	\$ 40,000	\$ 20
Less: Fixed costs	30,000	
Operating income	\$ 10,000	

$$\text{Total contribution margin} = \$40,000 \quad \text{Contribution margin per unit} = \$20$$

$$\text{Contribution margin ratio} = \$20 / \$50 = 40\%$$

$$\text{Contribution margin ratio} = 40,000 / 100,000 = 40\%$$

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Break-even Point (unit): Equation Method

Let Q = number of units to be sold to break even

Total revenues – VC – FC = Profit

$$\$50Q - \$30Q - \$30,000 = 0$$

$$\$20Q = \$30,000$$

$$Q = \$30,000 \div \$20$$

$$= 1,500 \text{ units}$$

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Break-even Point (unit): Formula Method

$$\text{Break-even point in units} = \frac{\text{Total Fixed costs}}{\text{Contribution margin per unit}}$$

$$\$30,000 \div \$20 = 1,500 \text{ units}$$

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Break-even Point (\$): Equation Method

Let R = Revenues at break even

Total revenues – VC – FC = Profit

$$R - 0.6R - \$30,000 = 0$$

$$0.4R = \$30,000$$

$$R = \$30,000 \div 0.4$$

$$= \$75,000$$

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Break-even Point (\$): Formula Method

$$\text{Break-even point in dollars} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

$$\$30,000 \div 0.4 = \$75,000$$

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Computing Break-Even Sales

ABC Co. sells product XYZ at \$5.00 per unit. If fixed costs are \$200,000 and variable costs are \$3.00 per unit, how many units must be sold to break even?

- a. 100,000 units
- b. 40,000 units
- c. 200,000 units
- d. 66,667 units

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Computing Break-Even Sales

Use the contribution margin ratio formula to determine the amount of sales revenue ABC must have to break even. All information remains unchanged: fixed costs are \$200,000; unit sales price is \$5.00; and unit variable cost is \$3.00.

- a. \$200,000
- b. \$300,000
- c. \$400,000
- d. \$500,000

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Quick Check ✓



Coffee Go is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the break-even sales in units?

- a. 872 cups
- b. 3,611 cups
- c. 1,200 cups
- d. 1,150 cups

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Quick Check ✓



Coffee Go is an espresso stand in a downtown office building. The average selling price of a cup of coffee is \$1.49 and the average variable expense per cup is \$0.36. The average fixed expense per month is \$1,300. 2,100 cups are sold each month on average. What is the break-even sales dollars?

- a. \$1,300
- b. \$1,715
- c. \$1,788
- d. \$3,129

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Computing Sales Needed to Achieve Target Operating Income (TOI)

Break-even formulas may be adjusted to show the sales volume needed to earn any amount of *operating income*.

$$\text{Unit sales} = \frac{\text{Fixed costs} + \text{TOI}}{\text{Contribution margin per unit}}$$

$$\text{Dollar sales} = \frac{\text{Fixed costs} + \text{TOI}}{\text{Contribution margin ratio}}$$

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Computing Sales Needed to Achieve Target *Operating* Income

ABC Co. sells product XYZ at \$5.00 per unit. If fixed costs are \$200,000 and variable costs are \$3.00 per unit, how many units must be sold to earn operating income of \$40,000?

- a. 100,000 units
- b. 120,000 units
- c. 80,000 units
- d. 200,000 units

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Margin of Safety (MOS)

- The margin of safety is the excess of budgeted (or actual) sales (in either revenue or units) over the break-even volume of sales. It indicates *the amount by which sales could drop before profits reach the breakeven point*.
 - ◆ MOS (units) = Actual or estimated units – Units at BEP
 - ◆ MOS (\$) = Actual or estimated revenue – Revenue at BEP
- The MOS percentage is the margin of safety divided by actual or estimated sales, in either units or revenues.
 - ◆ MOS Ratio = MOS in units ÷ Actual or estimated units
 - ◆ MOS Ratio = MOS in revenues ÷ Actual or estimated revenues

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Margin of Safety Example

- Actual sales = 120,000 units @ \$5 (Revenues = \$600,000)
- BE sales = 100,000 units @ \$5 (Revenues = \$500,000)
- MOS in units

= 120,000 – 100,000	= 20,000 units
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- MOS Ratio

= 20,000 ÷ 120,000	= 16.7%
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- MOS in revenues

= \$600,000 – \$500,000	= \$100,000
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- MOS Ratio

= \$100,000 ÷ \$600,000	= 16.7%
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Sensitivity Analysis

- CVP provides structure to answer a variety of “what-if” scenarios.
- “What” happens to profit “if”:
 - ◆ Selling price changes
 - ◆ Volume changes
 - ◆ Cost structure changes
 - Variable cost per unit changes
 - Fixed cost changes

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Sensitivity Analysis



Consider the following information developed by the accountant at Speedo, a bicycle retailer:

	Total	Per Unit	Percent
Sales (500 bikes)	\$ 250,000	\$ 500	100%
Less: variable expenses	150,000	300	60%
Contribution margin	\$ 100,000	\$ 200	40%
Less: fixed expenses	80,000		
Operating income	\$ 20,000		

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Sensitivity Analysis

- ① Should Speedo spend \$12,000 on advertising to increase unit sales by 10 percent?

	500 Bikes		550 Bikes
Sales	\$ 250,000	$550 \times \$500$	\$ 275,000
Less: variable expenses	150,000	$550 \times \$300$	165,000
Contribution margin	\$ 100,000		\$ 110,000
Less: fixed expenses	80,000		92,000
Operating income	\$ 20,000	$\$80K + \$12K$	\$ 18,000

No, income is decreased.



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Sensitivity Analysis

- ② Now, in combination with the advertising, Speedo is considering a 10 percent price reduction that will increase unit sales by 25 percent. What is the income effect?

	500 Bikes		625 Bikes
Sales	\$ 250,000	1.25×500	\$ 281,250
Less: variable expenses	150,000	$625 \times \$450$	187,500
Contribution margin	\$ 100,000	$625 \times \$300$	\$ 93,750
Less: fixed expenses	80,000		92,000
Operating income	\$ 20,000	$\$80K + \$12K$	\$ 1,750

Income is decreased even more.



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③ Now, in combination with advertising and a price cut, Speedo will replace \$50,000 in sales salaries with a \$25 per bike commission, increasing unit sales by 50 percent above the original 500 bikes. What is the effect on income?

	500 Bikes	1.5×500	→ 750 Bikes
Sales	\$ 250,000	$750 \times \$450$	\$ 337,500
Less: variable expenses	150,000		243,750
Contribution margin	\$ 100,000	$750 \times \$325$	\$ 93,750
Less: fixed expenses	80,000		42,000
Operating income	\$ 20,000	$\$92K - \$50K$	\$ 51,750

The combination of advertising, a price cut, and change in compensation increases income.

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Multi-Product Break-Even Analysis

- The formulae presented to this point have assumed a single product is produced and sold. A more realistic scenario involves multiple products sold, in different volumes, with different costs.
- A weighted-average CM must be calculated because different products have different selling prices, costs, and contribution margins.

$$\text{Weighted-average CM per unit} = \frac{\text{Total contribution margins}}{\text{Total units of all products}}$$

This new CM would be used in CVP equations

$$\text{Multi-Product BE} = \frac{\text{Fixed Costs}}{\text{Weighted Average CM per unit}}$$

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Multi-Product Break-Even Analysis



	Selling price per unit	Variable cost per unit	Contribution margin per unit	Units Sold
CD player	\$100	\$75	\$25	200
DVD player	\$200	\$100	\$100	400

Sales mix based on units sold → CD : DVD = 1 : 2

	CD Player	DVD Player	Total
Revenues	\$ 20,000	\$ 80,000	\$ 100,000
Variable costs	15,000	40,000	55,000
Contribution margin	\$ 5,000	\$ 40,000	\$ 45,000
Fixed cost			27,000
Operating income			\$ 18,000

Sales mix based on sales dollars → CD : DVD = 20% : 80%

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Multi-Product Break-Even Analysis



$$\text{Weighted-average CMU} = \frac{\$45,000}{600 \text{ units}} = \$75$$

or

$$\text{Weighted-average CMU} = (\$25 \times 1/3) + (\$100 \times 2/3) = \$75$$

$$\text{Multi-Product BE} = \frac{\text{Fixed Costs}}{\text{Weighted Average CM per unit}}$$

Sales mix based on units sold → CD : DVD = 1 : 2

$$\begin{aligned} \text{Total break-even in units is:} \\ = \$27,000 \div \$75 = 360 \text{ units} \end{aligned}$$

$$\text{CD Player } 360 \times 1/3 = 120 \text{ units}$$

$$\text{DVD Player } 360 \times 2/3 = 240 \text{ units}$$

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Multi-Product Break-Even Analysis



Proof:

	CD Player	DVD Player	Total
Units sold	120 units	240 units	
Revenues	\$ 12,000	\$ 48,000	\$ 60,000
Variable costs	9,000	24,000	33,000
Contribution margin	\$ 3,000	\$ 24,000	\$ 27,000
Fixed costs			27,000
Operating income			\$ -

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Multi-Product Break-Even Analysis

The weighted average CM% is = $\frac{\$45,000}{\$100,000} = 45\%$

$$\text{Multi-Product BE} = \frac{\text{Total Fixed Costs}}{\text{Weighted average CM\%}}$$

Total break-even in sales dollar is:

$$= \$27,000 \div 45\% = \$60,000$$

$$\text{CD Player} \quad \$60,000 \times 20\% = \$12,000$$

$$\text{DVD Player} \quad \$60,000 \times 80\% = \$48,000$$

Sales mix based on sales dollars → CD : DVD = 20% : 80%

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Differential Analysis

- ☉ Differential analysis focuses on relevant information only.
- ☉ Relevant costs (or relevant revenues) must meet two criteria:
 - ❶ They will occur in the future
 - ✱ Relevant Costs – expected future costs
 - ✱ Relevant Revenues – expected future revenues
 - ❷ They must differ between the alternatives being considered (*differential costs, differential revenues*)

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Relevant Costs

- ☉ *Sunk cost is a cost that has already been incurred and cannot be avoided regardless of what a manager decides to do; therefore, it is irrelevant.*
- ☉ *Historical costs may be useful basis for making informed predictions of expected future costs/revenue but they are irrelevant.*
- ☉ An **avoidable cost** is a cost that can be eliminated, in whole or in part, by choosing one alternative over another. They are **relevant costs**. In contrast, *unavoidable costs are irrelevant costs.*

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Differential Analysis: A Two-Step Process

Step 1 Eliminate costs and benefits that **DO NOT** differ between alternatives.

Step 2 Use the relevant costs and relevant benefits that differ between alternatives in making the decision.

Two examples of differential analyses:

- ❶ One-time-only special order decisions
- ❷ Make or buy decisions

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Types of Decisions:

❶ One-Time-Only Special Orders

⌚ Conditions:

- There is idle production capacity
- The special orders have no long-run implications

⌚ Compares *relevant revenues* and *relevant costs* to determine profitability

⌚ Decision Rule: does the special order generate additional operating income?

- Yes – accept
- No – reject

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Types of Decisions:

❶ One-Time-Only Special Orders

⌚ View Co. currently sells 100,000 units of its product.
The company has revenue and costs as shown below:

	Per Unit	Total
Sales	\$ 10.00	\$ 1,000,000
Direct materials	3.50	350,000
Direct labor	2.20	220,000
Factory overhead	1.10	110,000
Selling expenses	1.40	140,000
Administrative expenses	0.80	80,000
Total expenses	\$ 9.00	\$ 900,000
Operating income	\$ 1.00	\$ 100,000

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Types of Decisions:

❶ One-Time-Only Special Orders

View Co. is approached by an overseas company that offers to purchase 10,000 units at \$8.50 per unit.

The company has idle production capacity.

If View Co. accepts the offer, total factory overhead will increase by \$5,000; total selling expenses will increase by \$2,000; and total administrative expenses will increase by \$1,000.

Should View Co. accept the offer?

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Types of Decisions:

① One-Time-Only Special Orders

	Current Business	Additional Business	Combined
Sales	\$ 1,000,000	\$ 85,000	\$ 1,085,000
Direct materials	\$ 350,000	\$ 35,000	\$ 385,000
Direct labor	220,000	22,000	242,000
Factory overhead	110,000	5,000	115,000
Selling expenses	140,000	2,000	142,000
Admin. expenses	80,000	1,000	81,000
Total expenses	\$ 900,000	\$ 65,000	\$ 965,000
Operating income	\$ 100,000	\$ 20,000	\$ 120,000

Even though the \$8.50 selling price is less than the normal \$10 selling price, View Co. should accept the offer because net income will increase by \$20,000.

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Types of Decisions:

② Outsourcing vs. Insourcing

- Also called the "Make or Buy" decision
- Insourcing (Make)* – producing goods or services within an organization
- Outsourcing (Buy)* – purchasing goods or services from outside vendors
- Decision Rule: Select the option that will provide the firm with the lowest cost, and therefore the highest profit.

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Types of Decisions:

② Make or Buy Decision

- Excel makes computer chips used in one of its products. Unit costs, based on production of 20,000 chips per year, are:

	Unit Costs
Direct Material	\$ 9.00
Direct Labor	5.00
Variable Overhead	1.00
Fixed Overhead	13.00
Total	\$ 28.00

- An outside supplier has offered to provide the 20,000 chips at a cost of \$25 per chip. Fixed overhead costs will not be avoided if the chips are purchased. Excel has no alternative use for the facilities. **Should Excel accept the offer?**

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Types of Decisions:

② Make or Buy Decision

	Make	Buy
Direct material	(\$9 x 20,000) 180,000	-
Direct labor	(\$5 x 20,000) 100,000	-
Variable overhead	(\$1 x 20,000) 20,000	-
Fixed overhead	(\$13 x 20,000) 260,000	260,000
Purchase price	-	(\$25 x 20,000) 500,000
Total relevant costs	\$300,000	\$500,000

Excel should make computer chips. The total cost savings per year by making the products
 = \$500,000 - \$300,000 = \$200,000
 Fixed costs are *irrelevant* to decision.

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Types of Decisions:

② Make or Buy Decision

If Excel buys the chips from the outside supplier, the idle facilities could be leased to another company for \$250,000 per year.

Should Excel buy the chips and lease the facilities?

**New
Information**

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Types of Decisions:

② Make or Buy Decision

Disadvantage of buying	\$ 200,000
Opportunity cost of facilities:	
The lease revenue	250,000
Advantage of buying part and leasing facilities	\$ 50,000

The opportunity cost of facilities changes the decision.

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Qualitative Factors

☉ Nonquantitative factors may be extremely important in an evaluation process, yet do not show up directly in calculations:

- ☐ Quality Requirements
- ☐ Reputation of Suppliers
- ☐ Employee Morale
- ☐ Logistical Considerations – distance from plant, etc.

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