

Differential Analysis: The Key to Decision Making

Chapter 11 - Part I

Chapter theme

Making decisions is one of the basic functions of a manager. To be successful in decision making, managers must be able to perform differential analysis, which focuses on identifying the costs and benefits that differ between alternatives.

-> illustrating the use of these skills in a wide range of decision-making situations.

Learning Objective 1

Identify relevant and irrelevant costs and benefits in a decision.

Decision Making – Six Key Concepts

– Concepts 1 and 2

Key Concept #1

Every decision involves choosing from among **at least two alternatives**. Therefore, the first step in decision making is to **define the alternatives** being considered.

Key Concept #2

Once you have defined the alternatives, you need to **identify the criteria** for choosing among them.

- **Relevant costs** and **relevant benefits** should be considered when making decisions.
- **Irrelevant costs** and **irrelevant benefits** should be ignored when making decisions.

Decision Making – Six Key Concepts

– Concept 3

Key Concept #3

The key to effective decision making is ***differential analysis***—focusing on the future costs and benefits that differ between the alternatives. Everything else is irrelevant and should be ignored.

- A future cost that differs between any two alternatives is known as a **differential cost**.
- Future revenue that differs between any two alternatives is known as **differential revenue**.
- An **incremental cost** is an increase in cost between two alternatives.
- An **avoidable cost** is a cost that can be eliminated by choosing one alternative over another.

Decision Making – Six Key Concepts

– Concepts 4 and 5

Key Concept #4

Sunk costs are always irrelevant when choosing among alternatives.

- A **sunk cost** is a cost that has already been incurred and cannot be changed regardless of what a manager decides to do.

Key Concept #5

Future costs and benefits that *do not differ between alternatives* are irrelevant to the decision-making process.

Decision Making – Six Key Concepts – Concept 6

Key Concept #6

Opportunity costs also need to be considered when making decisions.

- An **opportunity cost** is the potential benefit that is given up when one alternative is selected over another.

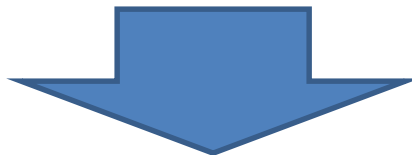
Diverse decision contexts

Keep or drop

Special order

Make or buy

Sell or process further



Financial advantage
(disadvantage)

Identifying Relevant Costs

- Cynthia, a Boston student, is considering visiting her friend in New York.
 - She can drive or take the train.
 - By car, it is 230 miles to her friend's apartment.
 - She is trying to decide which alternative is less expensive and has gathered the following information.
- Automobile Costs (based on 10,000 miles driven per year).

		Annual Cost of Fixed Items	Cost per Mile
1	Annual straight-line depreciation on car	\$ 2,800	\$ 0.280
2	Cost of gasoline		0.100
3	Annual cost of auto insurance and license	1,380	0.138
4	Maintenance and repairs		0.065
5	Parking fees at school	360	<u>0.036</u>
6	Total average cost		<u>\$ 0.619</u>

Identifying Relevant Costs

- Parking fees = $\$45 \text{ per month} \times 8 \text{ months} = \360
- Cost of gasoline = $\$2.70 \text{ per gallon} \div 27 \text{ MPG} = \0.100
- Depreciation = $(\$24,000 \text{ cost} - \$10,000 \text{ salvage value}) \div 5 \text{ years} = \$2,800$

Identifying Relevant Costs – Additional Information

Automobile Costs (based on 10,000 miles driven per year)

		Annual Cost of Fixed Items	Cost per Mile
1	Annual straight-line depreciation on car	\$ 2,800	\$ 0.280
2	Cost of gasoline		0.100
3	Annual cost of auto insurance and license	1,380	0.138
4	Maintenance and repairs		0.065
5	Parking fees at school	360	<u>0.036</u>
6	Total average cost		<u>\$ 0.619</u>

Additional Information

7	Reduction in resale value of car per mile of wear	\$ 0.026
8	Round –trip train fare	\$ 104
9	Benefits of relaxing on train trip	????
10	Cost of putting dog in kennel while gone	\$ 40
11	Benefit of having car in New York	????
12	Hassle of parking car in New York	????
13	Per day cost of parking car in New York	\$ 25

Identifying Relevant Costs

Which costs and benefits are relevant in Cynthia's decision?

- The cost of the car?
- The annual cost of insurance?
- The cost of gasoline?
- The cost of maintenance and repairs?
- The monthly school parking fee?
- The decline in resale value due to additional miles?
- The round-trip train fare?
- Relaxing on the train?
- The kennel cost?
- The cost of parking in New York?
- The benefits of having a car in New York and the problems of finding a parking?

Identifying Relevant Costs – Part 1

Which costs and benefits are relevant in Cynthia's decision?

- The cost of the car is a sunk cost and is **not relevant** to the current decision.
- The annual cost of insurance is **not relevant**. It will remain the same if she drives or takes the train.
- However, the cost of gasoline is clearly **relevant** if she decides to drive. If she takes the train, she would avoid the cost of the gasoline, so the cost differs between the alternatives.

Identifying Relevant Costs – Part 2

- The cost of maintenance and repairs is **relevant**. In the long-run, these costs depend upon miles driven.
- The monthly school parking fee is **not relevant** because it must be paid if Cynthia drives or takes the train.
- At this point, we can see that **some of the total average cost** of \$0.619 per mile are relevant and others are not.

Identifying Relevant Costs – Part 3

- The decline in resale value due to additional miles is a **relevant** cost.
- The round-trip train fare is clearly **relevant**. If she drives the cost can be avoided.
- Relaxing on the train is **relevant** even though it is difficult to assign a dollar value to the benefit.
- The kennel cost is **not relevant** because Cynthia will incur the cost if she drives or takes the train.

Identifying Relevant Costs – Part 4

- The cost of parking in New York is **relevant** because it can be avoided if she takes the train.
- The benefits of having a car in New York and the problems of finding a parking space are both **relevant** but are difficult to assign a dollar amount.

Identifying Relevant Costs – Part 5

Relevant Financial Cost of Driving

Gasoline (460 @ \$0.100 per mile)	\$ 46.00
Maintenance (460 @ \$0.065 per mile)	29.90
Reduction in resale (460 @ \$0.026 per mile)	11.96
Parking in New York (2 days @ \$25 per day)	<u>50.00</u>
Total	<u>\$ 137.86</u>

Relevant Financial Cost of Taking the Train

Round-trip ticket	<u>\$ 104.00</u>
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Identifying Relevant Costs – Decision

From a financial standpoint, Cynthia would be better off taking the train to visit her friend. Some of the non-financial factors may influence her final decision.

Total and Differential Cost Approaches

The example above focused on identifying the relevant cost and benefits of taking a train vs driving, everything else was ignored!

This method of decision analysis is called *differential approach*, as it focuses *solely* on the *relevant costs and benefits*.

Another method of decision analysis, called the *total cost approach*, includes *all the costs and benefits – relevant or not*.

When done correctly, the two methods always provide the same answer!

Total and Differential Cost Approaches – Total Cost Approach

The management of a company is considering a *new labor saving machine* that rents for \$3,000 per year. Data about the company's annual sales and costs with and without the new machine are:

	Current Situation	Situation With New Machine	Differential Costs and Benefits
Sales (5,000 units @ \$40 per unit)	\$ 200,000	\$ 200,000	-
Less variable expenses:			
Direct materials (5,000 units @ \$14 per unit)	70,000	70,000	-
Direct labor (5,000 units @ \$8 and \$5 per unit)	40,000	25,000	15,000
Variable overhead (5,000 units @ \$2 per unit)	10,000	10,000	-
Total variable expenses	120,000	105,000	-
Contribution margin	80,000	95,000	15,000
Less fixed expenses:			
Other	62,000	62,000	-
Rent on new machine	-	3,000	(3,000)
Total fixed expense:	62,000	65,000	(3,000)
Net operating income	\$ 18,000	\$ 30,000	12,000

Total and Differential Cost Approaches – Differential Cost Approach

- As you can see, the **only costs that differ** between the alternatives are the *direct labor costs savings* and the *increase in fixed rental costs*.
- We can efficiently analyze the decision by looking at the different costs and revenues and arrive at the same solution.

Financial Advantage of Renting the New Machine

Decrease in direct labor costs (5,000 units @ \$3 per unit)	\$ 15,000
Increase in fixed rental expenses	<u>(3,000)</u>
Financial advantage of renting the new machine	<u>\$ 12,000</u>

Total and Differential Cost Approaches

Using the differential approach is desirable for two reasons:

1. Only rarely will enough information be available to prepare detailed income statements for both alternatives.
2. Mingling irrelevant costs with relevant costs may cause confusion and distract attention away from the information that is really critical.

Learning Objective 2

**“Keep or drop” problems
(product line or other business
segment)**

Adding/Dropping Segments

- One of the most important decisions managers make is whether to add or drop a business segment.
- Ultimately, a decision to drop an old segment or add a new one is going to hinge primarily on its financial impact.
- To assess this impact, it is necessary to carefully analyze the costs.

Adding/Dropping Segments – Ex.

- Due to the declining popularity of digital watches, Lovell Company's digital watch line has not reported a profit for several years.
- Lovell is considering whether to keep this product line or drop it.

A Contribution Margin Approach

DECISION RULE

- Lovell should drop the digital watch segment only if its profit would increase.
- Lovell will **compare the contribution margin** that would be lost if the digital watch line was discontinued **to the fixed expenses** that would be avoided if the line was discontinued.

Adding/Dropping Segments – Example – Part 1

Segment Income Statement		
Digital Watches		
Sales		\$ 500,000
Less: variable expenses		
Variable manufacturing costs	\$ 120,000	
Variable shipping costs	5,000	
Commissions	75,000	200,000
Contribution margin		\$ 300,000
Less: fixed expenses		
General factory overhead	\$ 60,000	
Salary of line manager	90,000	
Depreciation of equipment	50,000	
Advertising - direct	100,000	
Rent - factory space	70,000	
General admin. expenses	30,000	400,000
Net operating loss		\$ (100,000)

Adding/Dropping Segments – Example – Part 2

- An investigation has revealed that **the fixed general factory overhead and fixed general administrative expenses** will not be affected by dropping the digital watch line.
- The fixed general factory overhead and general administrative expenses assigned to this product would be reallocated to other product lines.

Adding/Dropping Segments – Example – Part 3

- The equipment used to manufacture digital watches has no resale value or alternative use.
- Should Lovell retain or drop the digital watch segment?

Contribution Margin Approach Solution

Contribution Margin Solution		
Contribution margin lost if digital watches are dropped		\$ (300,000)
Less fixed costs that can be avoided		
Salary of the line manager	\$ 90,000	
Advertising - direct	100,000	
Rent - factory space	70,000	260,000
Financial disadvantage of dropping the digital watches product line		\$ (40,000)

Comparative Income Approach – Part 1

- The Lovell solution can also be obtained by preparing comparative income statements showing results with and without the digital watch segment.
- **Let's look at this second approach.**

Comparative Income Approach – Part 2 (1 of 2)

	Keep Digital Watches	Drop Digital Watches	Difference
Sales	\$ 500,000	\$ -	\$ (500,000)
Less variable expenses		-	
Manufacturing expenses	120,000	-	120,000
Shipping	5,000	-	5,000
Commissions	<u>75,000</u>	=	<u>75,000</u>
Total variable expenses	<u>200,000</u>	=	<u>200,000</u>
Contribution margin	<u>300,000</u>	=	<u>(300,000)</u>
Less fixed expenses:			
General factory overhead	60,000		
Salary of line Manager	90,000		
Depreciation	50,000		
Advertising- direct	100,000		
Rent- factory space	70,000		
General admin. Expenses	<u>30,000</u>	_____	_____
Total fixed expenses	<u>400,000</u>	_____	_____
Net operating loss	\$ (100,000)	_____	_____

Comparative Income Approach – Part 2 (2 of 2)

- Contribution margin: Difference \$(300,000)
- If the digital watch line is dropped, the company loses \$300,000 in contribution margin.

Comparative Income Approach – Part 3 (1 of 2)

	Keep Digital Watches	Drop Digital Watches	Difference
Sales	\$ <u>500,000</u>	\$ -	\$ <u>(500,000)</u>
Less variable expenses		-	
Manufacturing expenses	120,000	-	120,000
Shipping	5,000	-	5,000
Commissions	<u>75,000</u>	=	<u>75,000</u>
Total variable expenses	<u>200,000</u>	=	<u>200,000</u>
Contribution margin	<u>300,000</u>	=	<u>(300,000)</u>
Less fixed expenses:			
General factory overhead	60,000	60,000	-
Salary of line Manager	90,000		
Depreciation	50,000		
Advertising- direct	100,000		
Rent- factory space	70,000		
General admin. Expenses	<u>30,000</u>	_____	_____
Total fixed expenses	<u>400,000</u>	_____	_____
Net operating loss	\$ <u>(100,000)</u>	_____	_____

Comparative Income Approach – Part 3 (2 of 2)

- General factory overhead: Drop Digital Watches = \$60,000.
- The general factory overhead would be the same under both alternatives, so it is irrelevant.

Comparative Income Approach – Part 4 (1 of 2)

	Keep Digital Watches	Drop Digital Watches	Difference
Sales	<u>\$ 500,000</u>	<u>\$ -</u>	<u>\$ (500,000)</u>
Less variable expenses		-	
Manufacturing expenses	120,000	-	120,000
Shipping	5,000	-	5,000
Commissions	<u>75,000</u>	-	<u>75,000</u>
Total variable expenses	<u>200,000</u>	-	<u>200,000</u>
Contribution margin	<u>300,000</u>	-	<u>(300,000)</u>
Less fixed expenses:			
General factory overhead	60,000	60,000	-
Salary of line Manager	90,000	-	90,000
Depreciation	50,000		
Advertising- direct	100,000		
Rent- factory space	70,000		
General admin. Expenses	<u>30,000</u>	_____	_____
Total fixed expenses	<u>400,000</u>	_____	_____
Net operating loss	<u>\$ (100,000)</u>	_____	_____

Comparative Income Approach – Part 4 (2 of 2)

- Salary of line manager: Difference \$90,000.
- The salary of the product line manager would disappear, so it is relevant to the decision.

Comparative Income Approach – Part 5 (1 of 2)

	Keep Digital Watches	Drop Digital Watches	Difference
Sales	\$ <u>500,000</u>	\$ -	\$ <u>(500,000)</u>
Less variable expenses		-	
Manufacturing expenses	120,000	-	120,000
Shipping	5,000	-	5,000
Commissions	<u>75,000</u>	=	<u>75,000</u>
Total variable expenses	<u>200,000</u>	=	<u>200,000</u>
Contribution margin	<u>300,000</u>	=	<u>(300,000)</u>
Less fixed expenses:			
General factory overhead	60,000	60,000	-
Salary of line Manager	90,000	-	90,000
Depreciation	50,000	50,000	-
Advertising- direct	100,000		
Rent- factory space	70,000		
General admin. Expenses	<u>30,000</u>	_____	_____
Total fixed expenses	<u>400,000</u>	_____	_____
Net operating loss	\$ <u>(100,000)</u>	_____	_____

Comparative Income Approach – Part 5 (2 of 2)

- Depreciation: Drop Digital Watches \$50,000
- The depreciation is a sunk cost.
- Also, remember that the equipment has no resale value or alternative use, so the equipment and the depreciation expense associated with it are irrelevant to the decision.

Comparative Income Approach – Part 6 (1 of 2)

	Keep Digital Watches	Drop Digital Watches	Difference
Sales	\$ <u>500,000</u>	\$ -	\$ <u>(500,000)</u>
Less variable expenses		-	
Manufacturing expenses	120,000	-	120,000
Shipping	5,000	-	5,000
Commissions	<u>75,000</u>	-	<u>75,000</u>
Total variable expenses	<u>200,000</u>	-	<u>200,000</u>
Contribution margin	<u>300,000</u>	-	<u>(300,000)</u>
Less fixed expenses:			
General factory overhead	60,000	60,000	-
Salary of line Manager	90,000	-	90,000
Depreciation	50,000	50,000	-
Advertising- direct	100,000	-	100,000
Rent- factory space	70,000	-	70,000
General admin. Expenses	<u>30,000</u>	<u>30,000</u>	-
Total fixed expenses	<u>400,000</u>	<u>140,000</u>	<u>260,000</u>
Net operating loss	\$ <u>(100,000)</u>	\$ <u>(140,000)</u>	\$ <u>(40,000)</u>

Comparative Income Approach – Part 6 (2 of 2)

- Net operating loss: Difference \$(40,000)
- The complete comparative income statements reveal that Lovell would earn \$40,000 of additional profit by retaining the digital watch line.

Beware of Allocated Fixed Costs – Part 1

- Be aware that allocated fixed costs can distort the keep/drop decision.
- Lovell's managers may ask: "Why should we keep the digital watch segment when it's showing a **\$100,000 loss?**"

Beware of Allocated Fixed Costs – Part 2

The answer lies in the way we allocate **common fixed costs** to our products.

Beware of Allocated Fixed Costs – Part 3

- Including **unavoidable common fixed costs** makes the product line **appear to be unprofitable**, when in fact *dropping* the product line would **decrease the company's overall net operating income**.

Exercise

The Reagle Cycle company manufactures 3 types of bicycles – a dirt bike, a mountain bike, and a racing bike. Data on sales and expenses for the past quarter follow:

	Total	Dirt Bikes	Mountain Bikes	Racing Bikes
Sales	\$300,000	\$90,000	\$150,000	\$60,000
Variable manufacturing and selling expenses	<u>120,000</u>	<u>27,000</u>	<u>60,000</u>	<u>33,000</u>
Contribution margin	<u>180,000</u>	<u>63,000</u>	<u>90,000</u>	<u>27,000</u>
Fixed expenses:				
Advertising, traceable.	30,000	10,000	14,000	6,000
Depreciation of special equipment	23,000	6,000	9,000	8,000
Salaries of product-line managers	35,000	12,000	13,000	10,000
Allocated common fixed expenses*	<u>60,000</u>	<u>18,000</u>	<u>30,000</u>	<u>12,000</u>
Total fixed expenses	<u>148,000</u>	<u>46,000</u>	<u>66,000</u>	<u>36,000</u>
Net operating income (loss)	<u>\$ 32,000</u>	<u>\$17,000</u>	<u>\$ 24,000</u>	<u>\$ (9,000)</u>

*Allocated on the basis of sales dollars.

Management is concerned about the continued losses shown by the racing bikes and wants a recommendation as to whether the line should be discontinued. The special equipment used to produce racing bikes has no resale value and does not wear out.

Required:

1. What is the financial advantage (disadvantage) per quarter for discontinuing the racing bikes?
2. Should the production of racing bikes be discontinued?

[Ex.01]

1. The financial (disadvantage) of discontinuing the racing bikes is computed as follows:

Lost contribution margin		\$(27,000)
Fixed costs that can be avoided:		
Advertising, traceable	\$ 6,000	
Salary of the product-line manager	<u>10,000</u>	<u>16,000</u>
Financial (disadvantage) of discontinuing the Racing Bikes		<u>\$(11,000)</u>

The **depreciation** of the special equipment is a **sunk cost** and is **not relevant** to the decision. The common costs are allocated and will continue regardless of whether or not the racing bikes are discontinued; thus, they are not relevant to the decision.

Alternative Solution:

	Current Total	Total If Racing Bikes Are Dropped	Difference: Net Operating Income Increase or (Decrease)
Sales	\$300,000	\$240,000	\$(60,000)
Variable expenses	<u>120,000</u>	<u>87,000</u>	<u>33,000</u>
Contribution margin	<u>180,000</u>	<u>153,000</u>	<u>(27,000)</u>
Fixed expenses:			
Advertising, traceable	30,000	24,000	6,000
Depreciation on special equipment*	23,000	23,000	0
Salaries of product-line managers	35,000	25,000	10,000
Common allocated costs	<u>60,000</u>	<u>60,000</u>	<u>0</u>
Total fixed expenses	<u>148,000</u>	<u>132,000</u>	<u>16,000</u>
Net operating income	<u>\$ 32,000</u>	<u>\$ 21,000</u>	<u>\$(11,000)</u>

*Includes pro-rated loss on the special equipment if it is disposed of.

Learning Objective 3

**“Make or buy”
analysis.**

The Make or Buy Decision

- When a company is involved in more than one activity in the entire value chain, it is **vertically integrated**.
- A decision to carry out one of the activities in the value chain internally, rather than to buy externally from a supplier is called a **make or buy decision**.

Vertical Integration – Advantages

- Smoother flow of parts and materials
- Better quality control
- Realize profits

Vertical Integration – Disadvantages

- Companies may fail to take advantage of suppliers who can create **economies of scale advantage** by pooling demand from numerous companies.
- While the **economies of scale** factor can be appealing, a company must be careful to retain control over activities that are **essential to maintaining its competitive position**.

The Make or Buy Decision – An Example

Essex Company manufactures Part 4A that is used in one of its products. The unit product cost of this part is:

Direct materials	\$ 9
Direct labor	5
Variable overhead	1
Depreciation of special equip.	3
Supervisor's salary	2
General factory overhead	<u>10</u>
Unit product cost	<u>\$ 30</u>

The Make or Buy Decision – Part 1

The special equipment used to manufacture Part 4A has no resale value.

- The total amount of general factory overhead, which is allocated on the basis of direct labor hours, would be unaffected by this decision.
- The \$30 unit product cost is based on 20,000 parts produced each year.
- An outside supplier has offered to provide the 20,000 parts at a cost of \$25 per part.

Should the company stop making Part 4A and buy it from an outside supplier?

The Make or Buy Decision – Part 2

	Cost Per Unit	Cost of 20,000 Units Make	Cost of 20,000 Buy
Outside purchase price	<u>\$ 25</u>		\$ 500,000
Direct materials (20,000 units)	\$ 9	180,000	
Direct labor	5	100,000	
Variable overhead	1	20,000	
Depreciation of equip.	3	-	
Supervisor's salary	2	40,000	
Allocated gen. fact. overhead	<u>10</u>	=	<u> </u>
Total cost	<u>\$ 30</u>	<u>\$ 340,000</u>	<u>\$ 500,000</u>

The **avoidable costs** associated with making Part 4A include direct materials, direct labor, variable overhead, and the supervisor's salary.

The Make or Buy Decision – Part 3

Depreciation of equipment: Cost of 20,000 units to make

- The cost incurred to buy the equipment is a **sunk cost**; the depreciation simply spreads this sunk cost over the equipment's useful life.
- Equipment has no resale value.
- The special equipment and associated depreciation expense are **irrelevant**.

The Make or Buy Decision – Part 4

Allocated general factory overhead: Cost Per Unit \$10

- The allocated general factory overhead represents allocated costs common to all items produced in the factory and would continue unchanged.
- Thus, it is **irrelevant** to the decision.

The Make or Buy Decision – Part 5

- Financial advantage of making Part 4A is \$160,000 less than the cost of buying the part.
- Should we make or buy Part 4A?
- Given that the total avoidable costs are less than the cost of buying the part, Essex should **continue to make the part.**

Opportunity Cost

- **Opportunity costs** are not actual cash outlays and are not recorded in the formal accounts of an organization.
- An **opportunity cost** is the benefit that is foregone as a result of pursuing some course of action.
- If the space to make Part 4A had an alternative use, the opportunity cost would have been equal to the segment margin that could have been derived from the best alternative use of the space.