Chapter-02: Cost Behavior Analysis and Use

2.1: Cost Behavior:

Cost behavior refers to how a cost will change as the level of activity changes. Managers who understand how costs behave can predict how costs will change under various alternatives. Conversely, attempting to make decisions without a thorough understanding of cost behavior patterns can lead to disaster. For example, cutting back production of a product line might result in far less cost savings than managers assume if they confuse fixed costs with variable costs-leading to a drop in profits. To avoid such problems, managers must be able to accurately predict what costs will be at various activity levels.

This chapter briefly reviews the definitions of variable and fixed costs and then discusses the behavior of these costs. The chapter also introduces the concept of a mixed cost, which is a cost that has both variable and fixed cost elements. The chapter concludes by introducing a new income statement format-called the **contribution format**-in which costs are organized by behavior rather than by the traditional functions of production, sales, and administration.

2.2: Types of Cost Behavior Patterns:

In this chapter we will examine a third cost behavior pattern, known as a mixed or semi-variable cost. All three cost behavior patterns-variable, fixed, and mixed-are found in most organizations. The relative proportion of each type of cost in an organization is known as its **cost structure.** For example, an organization might have many fixed costs but few variable or mixed costs. Alternatively, it might have many variable costs but few fixed or mixed costs. In this chapter, we will concentrate on gaining a fuller understanding of the behavior of each type of cost and also we explore how cost structure impacts decisions.

a) Variable Costs: Variable cost is a cost whose total dollar amount varies in direct proportion to changes in the activity level. If the activity level doubles, the total variable cost also doubles. If the activity level increases by only 10%, then the total variable cost increases by 10% as well. For a cost to be variable, it must be variable with respect to something. That "something" is its activity base. An **activity base** is a measure of whatever causes the incurrence of variable cost. An activity base is sometimes referred to as a cost driver. Some of the most common activity bases are direct labor-hours, machine-hours, units produced, and units sold.

Examples of Variable Costs:

Type of Organization	Respect to Volume of Output
Merchandising company	Cost of goods (merchandise) sold
Manufacturing company	Direct materials Direct labor* Variable elements of manufacturing overhead: Indirect materials Lubricants Supplies Power

Both merchandising and manufacturing companies	Variable elements of selling and administrative costs: Commissions Shipping costs
Service organizations	Supplies, travel

True Variable versus Step-Variable Costs

Not all variable costs have exactly the same behavior pattern. Some variable costs behave in a true variable or proportionately variable pattern. Other variable costs behave in a step-variable pattern.

True Variable Costs: Direct material is a true or proportionately variable cost because the amount used during a period will vary in direct proportion to the level of production activity. Moreover, any amounts purchased but not used can be stored and carried forward to the next period as inventory.

Step-Variable Costs: The cost of a resource that is obtainable only in large chunks and that increases or decreases only in response to fairly wide changes in activity is known as a **step-variable cost.** For example, the wages of skilled repair technicians are often considered to be a step-variable cost. Such a technician's time can only be obtained in large chunks-it is difficult to hire a skilled technician on anything other than a full-time basis. Moreover, any technician's time not currently used cannot be stored as inventory and carried forward to the next period. If the time is not used effectively, it is gone forever. Furthermore, a repair technician can work at a leisurely pace if pressures are light but intensify his or her efforts if pressures build up. For this reason, small changes in the level of production may have no effect on the number of technicians employed by the company.

b) Fixed Costs: F*ixed cost* is a cost that does not change with an increase or decrease in the amount of goods or services produced or sold. Total fixed costs remain constant within the relevant range of activity. To continue the Nooksack Expeditions example, assume the company rents a building for $500 per month to store its equipment. Within the relevant range, the total amount of rent paid is the same regardless of the number of guests the company takes on its expeditions during any given month. Since fixed costs remain constant in total, the average fixed cost per unit becomes progressively smaller as the level of activity increases. If Nooksack Expeditions has only 250 guests in a month, the $500 fixed rental cost would amount to an average of $2 per guest. If there are 1,000 guests, the fixed rental cost would average only 50 cents per guest. Note that as the number of guests increases, the average fixed cost per unit drops, but it drops at a decreasing rate. The first guests have the biggest impact on the average fixed cost per unit.

Example: Jackson Hole Llamas is owned and operated by Jill Aanonsen/Hodges and David Hodges. The company provides guided tours to remote areas of Yellowstone National Park and the Jedediah Smith Wilderness, with the llamas carrying the baggage for the multiday treks. Jill and David operate out of their ranch in Jackson Hole, Wyoming, leading about 10 trips each summer season. All food is provided as well as tents and sleeping pads. Based on the number of guests on a trip, Jill and

David will decide how many llamas will go on the trip and how many will remain on the ranch. Llamas are transported to the trailhead in a special trailer. The company has a number of costs, some of which are listed below:

Cost	Cost Behavior
Food and beverage costs	Variable with respect to the number of guests and the length of the trip in days.
Truck and trailer operating costs	Variable with respect to the number of miles to the trailhead.
Guide wages	Step variable; Jill and David serve as the guides on most trips and hire guides only for larger groups.
Costs of providing tents	Step variable; Jill and David serve as the guides on most trips and hire guides only for larger groups.
Cost of feeding llamas	Variable with respect to the number of guests and length of the trip in days. Jackson Hole Llamas owns its tents, but they wear out through use and must be repaired or eventually replaced.
Property taxes	Variable with respect to the number of guests, and hence the number of llamas, on a trip. [Actually, the cost of feeding llamas may *decrease* with the number of guests on a trip. When a llama is on a trek, it lives off the land-eating grasses and other vegetation found in meadows and along the trail. When a llama is left on the ranch, it may have.

Types of fixed cost:

Committed Fixed Costs: Committed fixed costs are those expenses that you cannot simply eliminate from your budget. They are expenditures that are necessary, since you need the goods or services these costs support in order to run the business. Investments in facilities, equipment, and the basic organization that can't be significantly reduced even for short periods of time without making fundamental changes are referred to as **committed fixed costs.** Examples of such costs include depreciation of buildings and equipment, real estate taxes, insurance expenses, and salaries of top management and operating personnel. Even if operations are interrupted or cut back, committed fixed costs remain largely unchanged in the short term. During a recession, for example, a company won't usually eliminate key executive positions or sell off key facilities-the basic organizational structure and facilities ordinarily are kept intact. The costs of restoring them later are likely to be far greater than any short-run savings that might be realized.

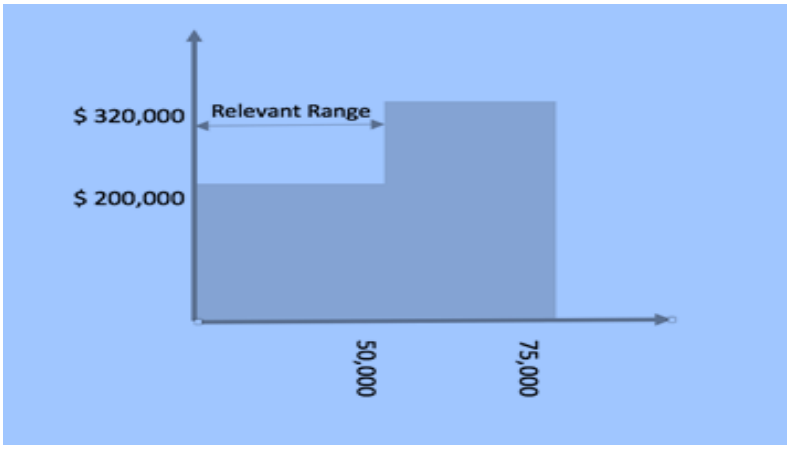
Discretionary Fixed Costs: Discretionary fixed cost is an expenditure for a period specific cost or a fixed asset, which can be eliminated or reduced without having an immediate impact on the reported profitability of a business. **Discretionary fixed**

costs (often referred to as managed fixed costs) usually arise from annual decisions by management to spend on certain fixed cost items. Examples of discretionary fixed costs include advertising, research, public relations, management development programs, and internships for students.

Two key differences exist between discretionary fixed costs and committed fixed costs. First, the planning horizon for a discretionary fixed cost is short term-usually a single year. By contrast, committed fixed costs have a planning horizon that encompasses many years. Second, discretionary fixed costs can be cut for short periods of time with minimal damage to the long-run goals of the organization. For example, spending on management development programs can be reduced because of poor economic conditions. Although some unfavorable consequences may result from the cutback, it is doubtful that these consequences would be as great as those that would result if the company decided to economize by laying off key personnel.

Fixed Costs and the Relevant Range:

When accounting for the costs of products and services, a company assumes that certain costs remain fixed as long as the level of activity stays within a certain range. This is the "relevant range," and it's a critical qualifier when budgeting and allocating fixed costs.



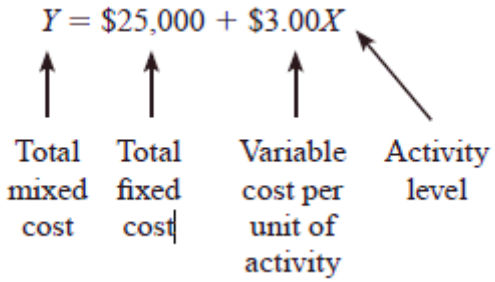
2.3: Mixed Costs:

A mixed cost contains both variable and fixed cost elements. Mixed costs are also known as semi variable cost. To continue the Nooksack Expeditions example, the company must pay a license fee of $25,000 per year plus $3 per rafting party to the state's Department of Natural Resources. If the company runs 1,000 rafting parties this year, then the total fees paid to the state would be $28,000, made up of $25,000 in fixed cost plus $3,000 in variable cost. Even if Nooksack fails to attract any customers, the company will still have to pay the license fee of $25,000. This is why the cost line in the **Exhibit** intersects the vertical cost axis at the $25,000 point. For each rafting party the company organizes, the total cost of the state fees will increase by $3. Therefore, the total cost line slopes upward as the variable cost of $3 per party is added to the fixed cost of $25,000 per year. Since the mixed cost in the **Exhibit** is

represented by a straight line, the following equation for a straight line can be used to express the relationship between a mixed cost and the level of activity:

Y =a + bX

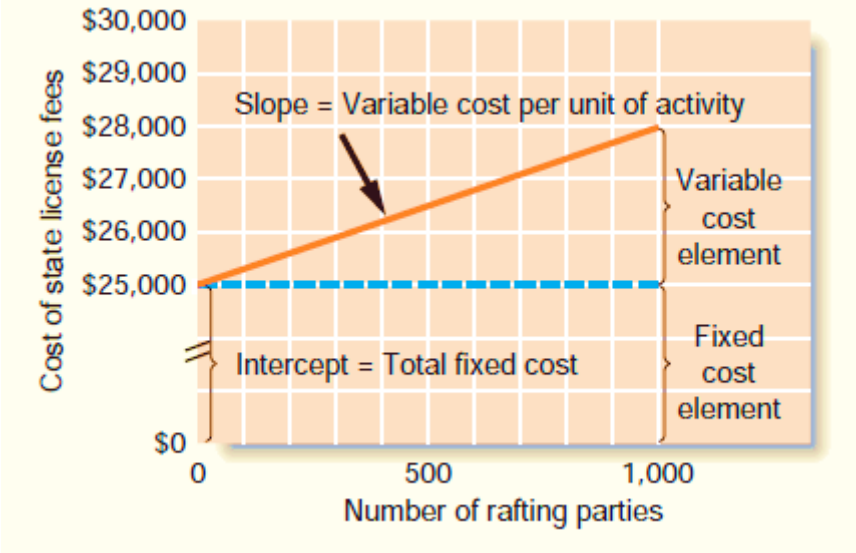
In this equation,
Y=The total mixed cost,
A=The total fixed cost
B=The variable cost per unit
X=The level of activity
Since the variable cost per unit equals the slope of the straight line, the steeper the slope, the higher the variable cost per unit. In the case of the state fees paid by Nooksack Expeditions, the equation is written as follows:



This equation makes it easy to calculate the total mixed cost for any level of activity within the relevant range. For example, suppose that the company expects to organize 800 rafting parties in the next year. The total state fees would be calculated as follows:

Y = $25,000 + ($3.00 per rafting party × 800 rafting parties)
= $27,400

Exhibit



2.4: Cost of Goods Manufactured:

Cost of Goods Manufactured, also known to as COGM, is a term used in managerial accounting that refers to a schedule or statement that shows the total production cost for a company during a specific period of time.

2.5: The High-Low Method:

In cost accounting, the high-low method is a way of attempting to separate out fixed and variable costs given a limited amount of data. The high-low method involves taking the highest level of activity and the lowest level of activity and comparing the total costs at each level. High-low methods are available for estimating fixed and variable costs. However, it must be emphasized that fixed and variable costs should be computed only if a scatter-graph plot confirms that the relation is approximately linear. In the case of maintenance costs at Brentline Hospital, the relation does appear to be linear. In the case of telephone costs, there isn't any clear relation between telephone costs and patient-days, so there is no point in estimating how much of the cost varies with patient-days. Assuming that the scattergraph plot indicates a linear relation between cost and activity, the fixed and variable cost elements of a mixed cost can be estimated using the high-low method or the least-squares regression method. The high-low method is based on the rise-over-run formula for the slope of a straight line.

High-Low Method Formula

$$\text{Variable Cost Per Unit} = \frac{\text{(Highest Activity Cost – Lowest Activity Cost)}}{\text{(Highest Activity Units – Lowest Activity Units)}}$$

$$\text{Fixed Cost} = \text{Highest Activity Cost – (Variable Cost Per Unit x Highest Activity Units)}$$

As discussed above, if the relation between cost and activity can be represented by a straight line, then the slope of the straight line is equal to the variable cost per unit of activity. Consequently, the following formula can be used to estimate the variable cost:

$$\text{Variable cost} = \text{Slope of the line} = \frac{\text{Rise}}{\text{Run}} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

To analyze mixed costs with the **high-low method,** begin by identifying the period with the lowest level of activity and the period with the highest level of activity. The period with the lowest activity is selected as the fi rst point in the above formula and the period with the highest activity is selected as the second point. Consequently, the formula becomes:

$$\text{Variable cost} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{\text{Cost at the high activity level} - \text{Cost at the low activity level}}{\text{High activity level} - \text{Low activity level}}$$

or

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}}$$

Therefore, when the high-low method is used, the variable cost is estimated by dividing the difference in cost between the high and low levels of activity by the change in activity

between those two points. To return to the Brentline Hospital example, using the high-low method, we first identify the periods with the highest and lowest **activity**-in this case, June and March. We then use the activity and cost data from these two periods to estimate the variable cost component as follows:

	Patient-Days	Maintenance Cost Incurred
High activity level (June).	8,000	$9,800
Low activity level (March)	5,000	7,400
Change.	3,000	$2,400

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2{,}400}{3{,}000 \text{ patient-days}} = \$0.80 \text{ per patient-day}$$

Having determined that the variable maintenance cost is 80 cents per patient-day, we can now determine the amount of fixed cost. This is done by taking the total cost at either the high or the low activity level and deducting the variable cost element. In the computation below, total cost at the high activity level is used in computing the fixed cost element:

Fixed cost element = Total cost - Variable cost element
= $9,800 - ($0.80 per patient-day × 8,000 patient-days)
= $3,400

Both the variable and fixed cost elements have now been isolated. The cost of maintenance can be expressed as $3,400 per month plus 80 cents per patient-day or as:

$$Y = \$3{,}400 + \$0.80X$$

Total maintenance cost — Total patient-days

2.6: The Least-Squares Regression Method:

The **least-squares regression method,** unlike the high-low method, uses all of the data to separate a mixed cost into its fixed and variable components. **A regression line of the form Y = a + bX is fitted to the data**, where a represents the total fixed cost and b represents the variable cost per unit of activity.

2.7: **Multiple Regression Analysis:**

In the discussion thus far, we have assumed that a single factor such as patient-days drives the variable cost component of a mixed cost. This assumption is acceptable for many mixed costs, but in some situations the variable cost element may be driven by a number of factors. For example, shipping costs may depend on both the number of units shipped *and* the weight of the units. In a situation such as this, multiple regression is necessary. **Multiple regression**

is an analytical method that is used when the dependent variable (i.e., cost) is caused by more than one factor. Although adding more factors, or variables, makes the computations more complex, the principles involved are the same as in the simple least-squares regressions discussed above.

2.8: Income Statement:

The income statement consists of revenues and expenses along with the resulting net income or loss over a period of time due to earning activities. The operating section of an income statement includes revenue and expenses. Although an income statement prepared in the functional format may be useful for external reporting purposes, it has serious limitations when used for internal purposes. Internally, managers need cost data organized in a format that will facilitate planning, control, and decision making. As we shall see in chapters ahead, these tasks are much easier when cost data are available in a fixed and variable format. The contribution format income statement has been developed in response to these needs.

The Contribution Approach

The following Exhibit uses a simple example to compare a contribution approach income statement to the traditional approach . Notice that the contribution approach separates costs into fixed and variable categories, First deducting variable expenses from sales to obtain the contribution margin. The **contribution margin** is the amount remaining from sales revenues after variable expenses have been deducted. This amount contributes toward covering fixed expenses and then toward profits for the period. The contribution format income statement is used as an internal planning and decision making tool. Its emphasis on cost behavior facilitates cost-volume-profit analysis (such as we shall be doing in the next chapter), management performance appraisals, and budgeting. Moreover, the contribution approach helps managers organize data pertinent to numerous decisions such as product-line analysis, pricing, use of scarce resources, and make or buy analysis.

Exhibit

Comparison of the Contribution Income Statement with the Traditional Income Statement (the data are given)

Traditional Approach (costs organized by function)			Contribution Approach (costs organized by behavior)		
Sales		$12,000	Sales		$12,000
Cost of goods sold		6,000*	Variable expenses:		
Gross margin		6,000	Variable production	$2,000	
Selling and administrative expenses:			Variable selling	600	
Selling	$3,100*		Variable administrative	400	3,000
Administrative	1,900*	5,000	Contribution margin		9,000
Net operating income		$ 1,000	Fixed expenses:		
			Fixed production	4,000	
			Fixed selling	2,500	
			Fixed administrative	1,500	8,000
			Net operating income		$ 1,000

*Contains both variable and fixed expenses. This is the income statement for a manufacturing company; thus, when the income statement is placed in the contribution format, the "cost of goods sold" is divided between variable production costs and fixed production costs. If this were the income statement for a *merchandising* company (which simply purchases completed goods from a supplier), then the cost of goods sold would be *all* variable.

EXERCISE

Review Problem-01: Cost Behavior

Neptune Rentals operates a boat rental service. Consider the following costs of the company over the relevant range of 5,000 to 8,000 hours of operating time for its boats:

	Hours of Operating Time			
	5,000	6,000	7,000	8,000
Total costs:				
Variable costs	$ 20,000	$?	$?	$?
Fixed costs	168,000	?	?	?
Total costs	$188,000	$?	$?	$?
Cost per hour:				
Variable cost	$?	$?	$?	$?
Fixed cost	?	?	?	?
Total cost per hour	$?	$?	$?	$?

Required: Compute the missing amounts, assuming that cost behavior patterns remain unchanged within the relevant range of 5,000 to 8,000 hours.

Solution:

The variable cost per hour can be computed as follows:

$20,000 ÷ 5,000 hours = $4 per hour

Therefore, the missing amounts are as follows:

	Hours of Operating Time			
	5,000	6,000	7,000	8,000
Total costs:				
Variable costs (@ $4 per hour)	$ 20,000	$ 24,000	$ 28,000	$ 32,000
Fixed costs	168,000	168,000	168,000	168,000
Total costs	$188,000	$192,000	$196,000	$200,000
Cost per hour:				
Variable cost	$ 4.00	$ 4.00	$ 4.00	$ 4.00
Fixed cost	33.60	28.00	24.00	21.00
Total cost per hour	$ 37.60	$ 32.00	$ 28.00	$ 25.00

Review Problem-02: High-Low Method

The administrator of Azalea Hills Hospital would like a cost formula linking the administrative costs involved in admitting patients to the number of patients admitted during a month. The admitting department's costs and the number of patients admitted during the immediately preceding eight months are given in the following table:

Month	Number of Patients Admitted	Admitting Department Costs
May	1,800	$14,700
June	1,900	$15,200
July	1,700	$13,700
August	1,600	$14,000
September	1,500	$14,300
October	1,300	$13,100
November	1,100	$12,800
December	1,500	$14,600

Required:

a) Use the high-low method to establish the fixed and variable components of admitting costs.

b) Express the fixed and variable components of admitting costs as a cost formula in the form: Y = a + bX.

Solution:

a) The first step in the high-low method is to identify the periods of the lowest and highest activity. Those periods are November (1,100 patients admitted) and June (1,900 patients admitted). The second step is to compute the variable cost per unit using those two data points:

Month	Number of Patients Admitted	Admitting Department Costs
High activity level (June)	1,900	$15,200
Low activity level (November)	1,100	12,800
Change	800	$ 2,400

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$2{,}400}{800 \text{ patients admitted}} = \$3 \text{ per patient admitted}$$

The third step is to compute the fixed cost element by deducting the variable cost element from the total cost at either the high or low activity. In the computation below, the high point of activity is used:

Fixed cost element = Total cost - Variable cost element

= $15,200 - ($3 per patient admitted × 1,900 patients admitted)

= $9,500

b) The cost formula is Y = $9,500 + $3X.

Exc-01: Cost Behavior; High-Low Method

Speedy Parcel Service operates a fleet of delivery trucks in a large metropolitan area. A careful study by the company's cost analyst has determined that if a truck is driven 120,000 miles during a year, the average operating cost is 11.6 cents per mile. If a truck is driven only 80,000 miles during a year, the average operating cost increases to 13.6 cents per mile.

Required:

a) Using the high-low method, estimate the variable and fixed cost elements of the annual cost of truck operation.
b) Express the variable and fixed costs in the form $Y = a + bX$.
c) If a truck were driven 100,000 miles during a year, what total cost would you expect to be incurred?

Exc-02: High-Low Method; Predicting Cost

The number of X-rays taken and X-ray costs over the last nine months in Beverly Hospital are given below:

Month	X-Rays Taken	X-Ray Costs
January	6,250	$28,000
February	7,000	$29,000
March	5,000	$23,000
April	4,250	$20,000
May	4,500	$22,000
June	3,000	$17,000
July	3,750	$18,000
August	5,500	$24,000
September	5,750	$26,000

Required:

a) Using the high-low method, estimate the cost formula for X-ray costs.
b) Using the cost formula you derived above, what X-ray costs would you expect to be incurred during a month in which 4,600 X-rays are taken?

Exc-03:

NuWay, Inc., manufactures a single product. Selected data from the company's cost records for two recent months are given below:

	Level of Activity	
	July—Low	October—High
Number of units produced	9,000	12,000
Cost of goods manufactured	$285,000	$390,000
Work in process inventory, beginning	$14,000	$22,000
Work in process inventory, ending	$25,000	$15,000
Direct materials cost per unit	$15	$15
Direct labor cost per unit	$6	$6
Manufacturing overhead cost, total	?	?

The company's manufacturing overhead cost consists of both variable and fixed cost elements. To have data available for planning, management wants to determine how much of the overhead cost is variable with units produced and how much of it is fixed per year.

Required:

a) For both July and October, estimate the amount of manufacturing overhead cost added to production. The company had no under-applied or over-applied overhead in either month. (Hint: A useful way to proceed might be to construct a schedule of cost of goods manufactured.)
b) Using the high-low method, estimate a cost formula for manufacturing overhead. Express the variable portion of the formula in terms of a variable rate per unit of product.
c) If 9,500 units are produced during a month, what would be the cost of goods manufactured? (Assume that the company's beginning work in process inventory for the month is $16,000 and that its ending work in process inventory is $19,000. Also assume that there is no under-applied or over-applied overhead cost for the month.

Glossary

Account analysis: A method for analyzing cost behavior in which an account is classified as either variable or fixed based on the analyst's prior knowledge of how the cost in the account behaves.

Activity base: A measure of whatever causes the incurrence of a variable cost. For example, the total cost of X-ray film in a hospital will increase as the number of X-rays taken increases. Therefore, the number of X-rays is the activity base that explains the total cost of X-ray film.

Committed fixed costs: Investments in facilities, equipment, and basic organizational structure that can't be significantly reduced even for short periods of time without making fundamental changes.

Contribution approach: An income statement format that organizes costs by their behavior. Costs are separated into variable and fixed categories rather than being separated according to organizational functions.

Contribution margin: The amount remaining from sales revenues after all variable expenses have been deducted.

Cost structure: The relative proportion of fixed, variable, and mixed costs in an organization.

Dependent variable: A variable that responds to some causal factor; total cost is the dependent variable, as represented by the letter *Y*, in the equation $Y = a + b\text{X}$.

Discretionary fixed costs: Those fixed costs that arise from annual decisions by management to spend on certain fixed cost items, such as advertising and research.

Engineering approach: A detailed analysis of cost behavior based on an industrial engineer's evaluation of the inputs that are required to carry out a particular activity and of the prices of those inputs.

High-low method: A method of separating a mixed cost into its fixed and variable elements by analyzing the change in cost between the high and low activity levels.

Independent variable: A variable that acts as a causal factor; activity is the independent variable, as represented by the letter *X*, in the equation $Y = a + b\text{X}$.

Least-squares regression method: A method of separating a mixed cost into its fixed and variable elements by fitting a regression line that minimizes the sum of the squared errors.
Linear cost behavior: Cost behavior is said to be linear whenever a straight line is a reasonable approximation for the relation between cost and activity.
Mixed cost: A cost that contains both variable and fixed cost elements.
Multiple regression: An analytical method required when variations in a dependent variable are caused by more than one factor.
***R* 2:** A measure of goodness of fit in least-squares regression analysis. It is the percentage of the variation in the dependent variable that is explained by variation in the independent variable.
Relevant range: The range of activity within which assumptions about variable and fixed cost behavior are reasonably valid.
Step-variable cost: The cost of a resource that is obtainable only in large chunks and that increases and decreases only in response to fairly wide changes in activity.