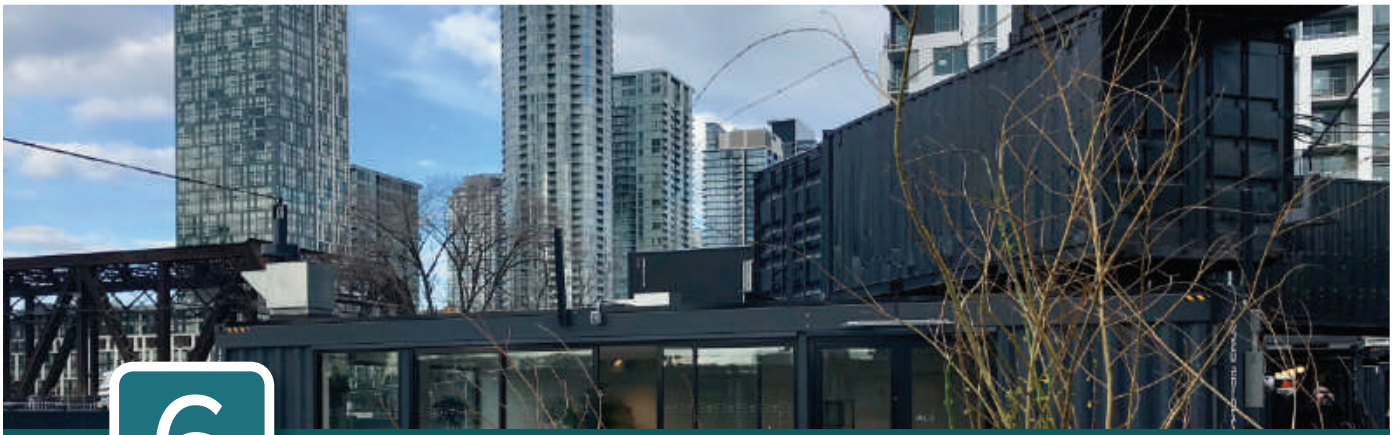


6

Cost Behaviour: Analysis and Use

LEARNING OBJECTIVES AND CHAPTER COMPETENCIES			
After studying Chapter 6, you should be able to demonstrate the following competencies:			
COMPETENCY		**Know**	**Apply**
LO1	**UNDERSTAND COST BEHAVIOUR.**		
CC1	Describe the behaviour of variable costs.	•	
CC2	Describe the behaviour of step-variable costs.	•	
CC3	Describe the behaviour of fixed costs.	•	
CC4	Explain committed and discretionary fixed costs.	•	
CC5	Explain the importance of relevant range in understanding fixed costs.	•	
CC6	Describe the behaviour of mixed costs.	•	
LO2	**ANALYZE AND ESTIMATE COSTS.**		
CC7	Construct a basic linear cost equation, and explain the individual elements of the cost equation.	•	•
CC8	Explain the importance of separating mixed costs into fixed and variable portions.	•	
CC9	Describe the high-low method of analyzing mixed costs, and set up a cost equation using this method.	•	•
CC10	Explain the scattergraph method of analyzing mixed costs, and set up a cost equation using this method.	•	•
CC11	Explain the least-squares regression method of analyzing mixed costs, and set up a cost equation using this method.	•	•
LO3	**COMPUTE CONTRIBUTION MARGIN AND INCOME.**		
CC12	Explain the concept of contribution margin, and prepare a contribution margin income statement.	•	•

ON THE JOB

DRAGON HELPS BUILD THE MODULAR BUSINESS

Imagine getting more than the "ask" (the amount you asked for) from a dragon on CBC's *Dragons' Den!* This is what Bryan McCrea and Evan Willoughby of Saskatoon-based 3twenty Modular experienced after impressing the investors with their modular building company. For many industries, utilizing prefab buildings is more cost effective, reduces risk, and shortens timelines.

McCrea and Willoughby got together in 2009 to convert used shipping containers into modular structures for offices and accommodations. While the company started out providing container-based buildings to resource industries, declining commodity prices encouraged 3twenty to innovate and diversify into new product lines and markets. 3twenty now custom builds modular buildings out of a steel–wood hybrid system and focuses primarily on the education, institutional, commercial, and First Nations markets. In fact, the company just finished a fully modularized high school for Mistawawsis Nêhiyawak.

As a co-owner and the accountant, McCrea is pleased that the company continues to be able to grow amid a difficult economy. "Diversifying into new markets was crucial," explains McCrea, and he knows that they need to continue to innovate to be successful. 3twenty understands the importance of a quality product, and that quality comes at a price. McCrea knows that cost control is critical to realizing the budgeted profit margins. A significant variable cost is subcontractors; however, controlling fixed costs is McCrea's goal. "We are trying to operate as a lean outfit although our fixed costs have grown significantly over the last few years," McCrea says. 3twenty subcontracts certain scopes of work, like mechanical install and steel fabrication (a variable cost). However, hiring full-time mechanical tradespeople and investing in the equipment to properly fabricate structural steel will change these costs from variable to fixed regardless of the number of buildings being built. Direct labour is also a fixed cost. "Our production team is efficient, but we often have a small period of downtime between jobs. Although we don't regret having to pay our workers during transitions, it is important that we find alternative ways to generate revenues to cover the downtime costs." This has come to fruition: 3twenty now generates additional revenue through its rental division and establishing multi-year contracts with certain customers.

According to McCrea, being on *Dragons' Den* was a great experience. Having one of Canada's top oil and gas investors—dragon W. Brett Wilson—on board adds credibility to the business and provides a comfort level to the young entrepreneurs. "We can turn to him for advice when we need it; he can also help us fill any shortfalls in our working capital," adds McCrea.

Sources: http://3twenty.ca/; conversation with Bryan McCrea, co-founder.

3twenty Modular

? **Critical thinking question** *How does the knowledge of cost behaviour help businesses control costs?*

*Note to student: See **Guidance Answers** online.*

A Look Back	A Look at This Chapter	A Look Ahead
We briefly introduced cost concepts in Chapter 2, followed by cost accounting and cost allocation methods in Chapters 3, 4, and 5.	After reviewing the behaviour of variable and fixed costs introduced in Chapter 2, we will discuss mixed costs—a third type of behavioural pattern—and provide an overview of the methods that can be used to break a mixed cost into its variable and fixed components. We also introduce the contribution format income statement, which is used for internal decision making.	Chapters 7, 8, and 9 focus on planning and decision making. Specifically, Chapter 7 describes the process of budgeting, whereas both Chapters 8 and 9 focus on decision making. Chapter 8 introduces the concept of cost–volume–profit analysis and break-even. Chapter 9 discusses relevant costs and their use in decision making.

In our discussion of cost terms and concepts in Chapter 2, we stated that one way to classify costs is by behaviour. We defined cost behaviour as the way a cost reacts or changes as changes take place in the level of business activity. As we will see in later chapters, an understanding of cost behaviour is important for the purposes of planning, making decisions, and controlling costs. Managers who understand how costs behave are better able to predict costs under varying operating conditions. Attempts at planning and decision making without a thorough understanding of the costs involved—and how these costs may change with the activity level—can lead to disaster. For example, a decision to cut back a particular product line might result in far less cost savings than managers may have estimated if they confuse variable and fixed costs, thereby leading to a decline in profits. To avoid such problems, a manager must be able to accurately predict costs at different activity levels. In this chapter, we will find that the key to effective cost prediction lies in understanding variable and fixed costs.

In this chapter, we briefly review the definitions of variable costs and fixed costs and then discuss the behaviour of these costs in greater depth than we were able to do in Chapter 2. After this review and discussion, we turn our attention to the analysis of mixed costs. We conclude the chapter by introducing a new income statement format—called the *contribution format*—in which costs are organized by behaviour rather than by the traditional functions of production, sales, and administration.

MANAGERIAL ACCOUNTING IN ACTION

THE ISSUE

Dr. Derek Chalmers, the chief executive officer of Mid-Town Medical Centre (MMC), motioned Kinh Nguyen, the chief financial officer of the hospital, to come into his office.

Chalmers: Kinh, come on in.

Nguyen: What can I do for you?

Chalmers: Actually, I wanted to talk to you about our maintenance expenses. I don't usually pay attention to such things, but these expenses seem to be bouncing around a lot. Over the last half-year or so, they have been as low as $7,400 and as high as $9,800 per month.

Nguyen: Actually, that's a pretty normal variation in those expenses.

Chalmers: Well, we budgeted a constant $8,400 a month. Can't we do a better job of predicting what these costs are going to be? And how do we know when we've spent too much in a month? Shouldn't there be some explanation for these variations?

Nguyen: Now that you mention it, we are in the process right now of tightening up our budgeting process. Our first step is to break all of our costs down into fixed and variable components.

Chalmers: How will that help?

Nguyen: Well, that will permit us to predict what the level of costs will be. Some costs are fixed and shouldn't change much. Other costs go up and down as our activity level goes up and down. The trick is to figure out what is driving the variable component of the costs.

Chalmers: What about the maintenance costs?

Nguyen: My guess is that the variations in maintenance costs are being driven by our overall level of activity. When we treat more patients, our equipment is used more intensively, which leads to more maintenance expense.

Chalmers: How would you measure the level of overall activity? Would you use patient-days?

Nguyen: I think so. Each day a patient is in the hospital counts as one patient-day. The greater the number of patient-days in a month, the busier we are. Besides, our budgeting is all based on projected patient-days.

Chalmers: Okay, so suppose you are able to break the maintenance costs down into fixed and variable components. What will that do for us?

Nguyen: Basically, I will be able to predict what maintenance costs should be as a function of the number of patient-days.

Chalmers: I can see where that would be useful. We could use it to predict costs for budgeting purposes.

Nguyen: We could also use it as a benchmark. On the basis of the actual number of patient-days for a period, I can determine what the maintenance costs should have been. We can compare this with the actual spending on maintenance.

Chalmers: Sounds good to me. Let me know when you get the results.

Before we go any further in answering the question posed by Dr. Derek Chalmers, let us review the different patterns of cost behaviour.

Types of Cost Behaviour Patterns

In Chapter 2, we mentioned only variable and fixed costs. In this chapter, we will discuss a third behaviour pattern, generally known as *mixed* cost. All three cost behaviour patterns—variable, fixed, and mixed—are found in most organizations. The relative proportion of each type of cost present in a firm determines its **cost structure**. For example, a firm might have a higher proportion of fixed costs and a relatively lower proportion of variable or mixed costs. A firm's cost structure can have a significant impact on decisions. In this chapter, we will concentrate on getting a better understanding of the different types of cost behaviour.

Variable Costs

LO1 • Know

CC1: Describe the behaviour of variable costs.

We explained in Chapter 2 that a variable cost is a cost whose total dollar amount varies in direct proportion to changes in the activity level. For example, if the activity level increases by 10%, then the total dollar amount of the variable cost will also increase by 10%.

We also found in Chapter 2 that a variable cost remains constant when expressed on a *per-unit* basis. To provide an example, consider 50 Plus Expeditions, a Toronto-based company that organizes adventure travel for people over the age of 50. Among other things, the company provides all of the necessary equipment and experienced guides and serves meals to its guests. Assume that the meals cost $30 per guest for a daylong excursion; the total cost of meals will vary depending upon the number of guests, as illustrated in the table.

Number of Guests	Cost of Meals per Guest	Total Cost of Meals
100	$30	$ 3,000
500	30	15,000
1,000	30	30,000

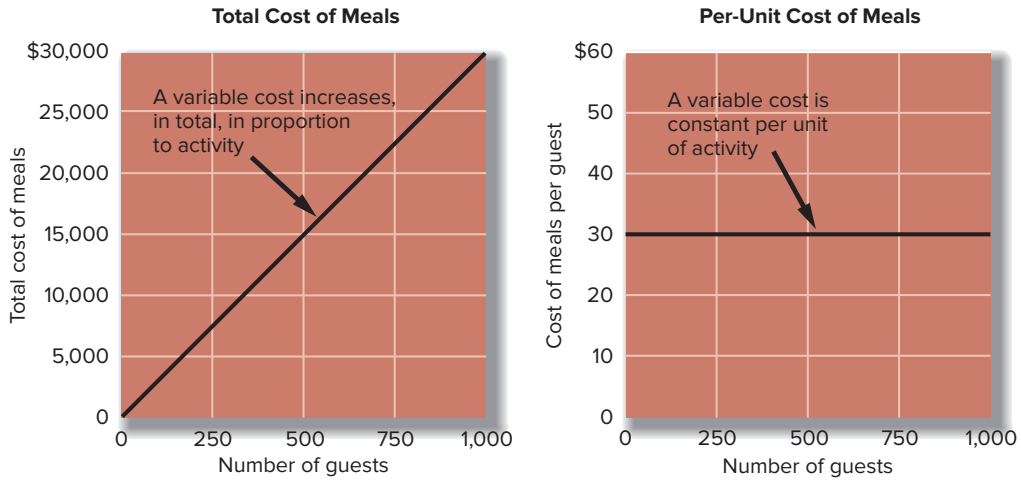
The idea that a variable cost is *constant per unit*, but *varies in total* with the activity level, is crucial to an understanding of cost behaviour patterns; Exhibit 6–1 provides a graphic illustration of variable cost behaviour. We shall return to this concept repeatedly in this chapter and in the chapters ahead.

THE ACTIVITY BASE 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 a variable cost. An activity base is also sometimes referred to as a *cost driver*. Activity bases may be output-based or input-based. Common output-based activity measures are volume of goods or services sold, number of customers served, and number of patients treated. Common input-based activity measures include direct labour-hours, machine-hours, number of customer service calls, and kilograms of raw materials used.

To plan and control variable costs, a manager must be well acquainted with the various activity bases within the firm. People sometimes think that if a cost does not vary with production or with sales, then it is not really a variable cost. This is not correct. As suggested by the range of bases listed above, costs are caused by many different activities within an organization. Whether a cost is considered to be variable depends on whether it is caused by the activity under consideration. For example, if a manager is analyzing the cost of service calls, the relevant activity measure will be the number of service calls made. Those costs that vary in total with the number of service calls made are the variable costs of making service calls.

Generally, most organizations are interested in classifying costs as variable or fixed using an appropriate output-based activity measure as the base (e.g., volume of goods or services sold). Doing this allows management to make crucial decisions and assess profitability using output as the basis; we will elaborate on this in later chapters.

EXHIBIT 6–1 Variable Cost Behaviour



DECISION POINT

BUDGET ANALYST

You are the budget analyst for a firm that provides janitorial services to other companies. You have been asked to estimate the costs that will be incurred on the janitorial jobs that will be performed next year. What types of costs would you expect? How would you characterize these costs in terms of behaviour? What activity would you need to measure in order to estimate the costs?

*Note to student: See **Guidance Answers** online.*

EXTENT OF VARIABLE COSTS The number and type of variable costs present in an organization will depend, in large part, on the organization's structure and purpose. A public utility such as BC Hydro, with large investments in equipment, will tend to have few variable costs. Most of the costs are associated with its plant, and these costs tend to be insensitive to changes in levels of service provided. A manufacturing company such as Black & Decker, in contrast, will often have many variable costs. These costs will be associated with both manufacturing and distributing its products to customers.

A merchandising company, such as Walmart or Canadian Tire, will usually have a high proportion of variable costs in its cost structure. In most merchandising companies, the cost of merchandise purchased for resale—a variable cost—constitutes a large component of total cost. Service companies, by contrast, have diverse cost structures. On the one hand, some service companies, such as the Pizza Pizza restaurant chain, have fairly large variable costs because of the costs of their raw materials. On the other hand, service companies involved in consulting, auditing, engineering, dental, medical, and architectural activities have very large fixed costs in the form of expensive facilities and highly trained salaried employees.

Some of the more frequently encountered variable costs are listed in Exhibit 6–2. This exhibit is not a complete listing of all costs that can be considered variable. Moreover, some of the costs listed in the exhibit may behave more like fixed costs than like variable costs in some firms. We will see some examples of this later in the chapter. Nevertheless, Exhibit 6–2 provides a useful listing of many of the costs that normally would be considered variable with respect to the volume of output.

EXHIBIT 6–2
Examples of Variable Costs

Type of Organization	Costs That Are Normally Variable With Respect to Volume of Output
Merchandising company	Cost of goods (merchandise) sold
Manufacturing company	Manufacturing costs:
	Direct materials
	Direct labour*
	Variable portion of manufacturing overhead:
	Indirect materials
	Lubricants
	Supplies
Both merchandising and manufacturing companies	Selling, general, and administrative costs:
	Commissions
	Clerical costs, such as invoicing
	Shipping costs
Service organizations	Supplies, travel, clerical

*Direct labour may or may not be variable in practice (see the On the Job box at the beginning of this chapter). Also see the discussion later in this chapter.

True Variable Versus Step-Variable Costs

LO1 • **Know**

CC2: Describe the behaviour of step-variable costs.

Not all variable costs have exactly the same behaviour pattern. Some variable costs behave in a *true variable* or *proportionately variable* pattern. Other variable costs behave in a *step-variable* pattern. Let us examine these costs, using Pizza Pizza as an example.

TRUE VARIABLE COSTS **True variable costs** are those that vary in direct proportion to changes in the level of activity. The cost of direct materials is a true variable cost because the amount used during a period will vary in direct proportion to the number of customers served or pizzas served. Moreover, any amounts purchased but not used can be stored and carried forward to the next period as inventory (remember that just-in-time purchasing is extremely important in the restaurant business because direct materials are perishable items).

STEP-VARIABLE COSTS A cost that increases or decreases only in response to more than a unit change in the activity level is known as a **step-variable cost**. The behaviour of a step-variable cost, contrasted with the behaviour of a true variable cost, is illustrated in Exhibit 6–3.

For example, one waiter at Pizza Pizza might be able to serve a total of 80 customers in a four-hour shift. However, when the number of customers is expected to be between 80 and 160, management must plan to have two waiters, and three if the number of customers expected is between 160 and 240. Thus, the number of waiters required depends on *block changes* in the number of customers. Moreover, when additional waiter time is obtained, it usually comes in indivisible blocks of, say, four or eight hours. It is reasonable to expect that Pizza Pizza will require additional waiters on weekends due to the higher number of customers typically expected. The strategy of management in dealing with step-variable costs must be to obtain the fullest use of services possible for each step. Great care must be taken in working with these kinds of costs in order to prevent "fat" (or excess) from building up in an organization. There may be a tendency to employ additional help more quickly than needed, and there is a natural reluctance to lay staff off when volume declines.

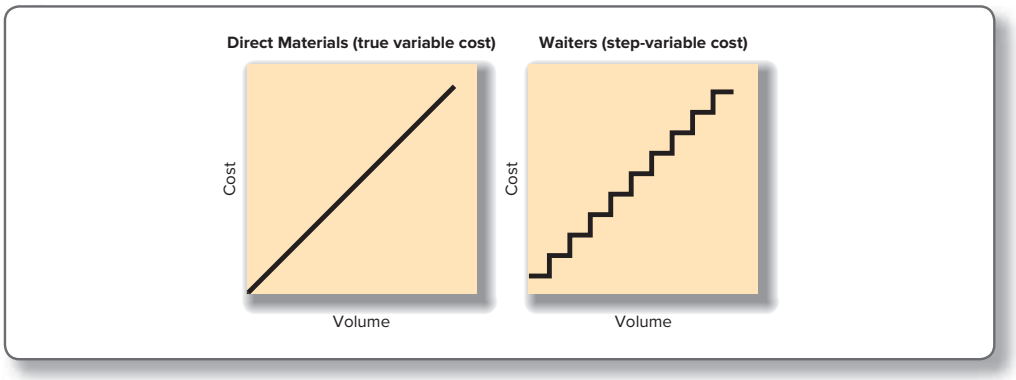


EXHIBIT 6–3
True Variable Versus Step-Variable Costs

CONCEPT CHECK

1. Which of the following cost behaviour assumptions are false? (You may select more than one answer.)
   a. Variable cost per unit increases as the activity level increases.
   b. The average fixed cost per unit decreases as the activity level increases.
   c. Total variable costs decrease as the activity level decreases.
   d. Total fixed costs remain the same as the activity level changes (within the relevant range).

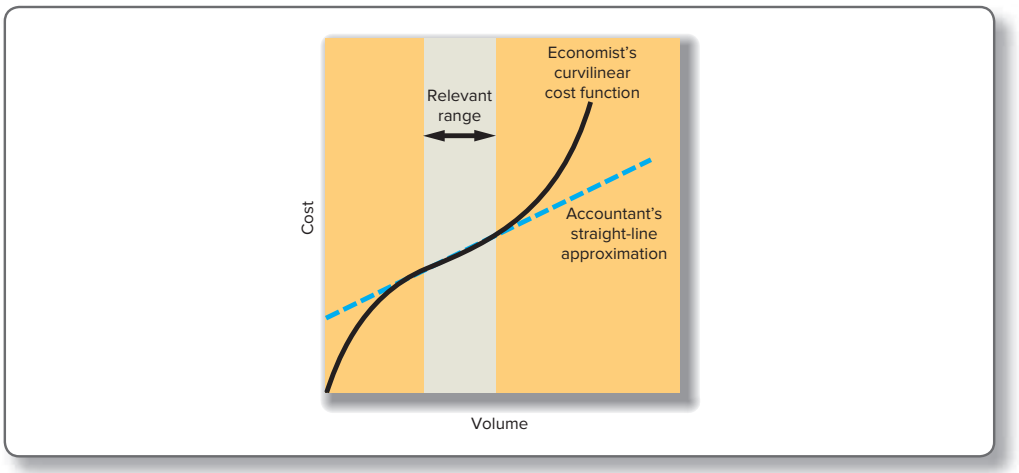
*Note to student: See **Guidance Answers** online.*

The Linearity Assumption and the Relevant Range

In dealing with variable costs, we have assumed a strictly linear relationship between cost and volume, except in the case of step-variable costs. Economists correctly point out that many costs classified as variable by the accountant actually behave in a *curvilinear* fashion. This is because the marginal productivity of variable inputs (e.g., direct materials and direct labour) is not constant. Instead, it shows an increasing trend that tapers off after some time and picks up again. The behaviour of a **curvilinear cost** is shown in Exhibit 6–4.

Although many costs are not strictly linear when plotted as a function of volume, a curvilinear cost can be satisfactorily approximated as a straight line within a narrow band of activity known as the *relevant range*. The **relevant range** is the range of activity within which the assumptions made about cost behaviour by the manager are valid. For example, note that the dashed line in Exhibit 6–4 can be used as an approximation to the curvilinear cost with little loss of accuracy within the relevant range (*grey area*). However, outside of the relevant range, this particular straight line is a poor approximation to the curvilinear cost relationship. Managers should always keep in mind that a particular assumption made about cost behaviour may be inappropriate if activity falls outside of the relevant range.

EXHIBIT 6–4
Curvilinear Costs and the Relevant Range

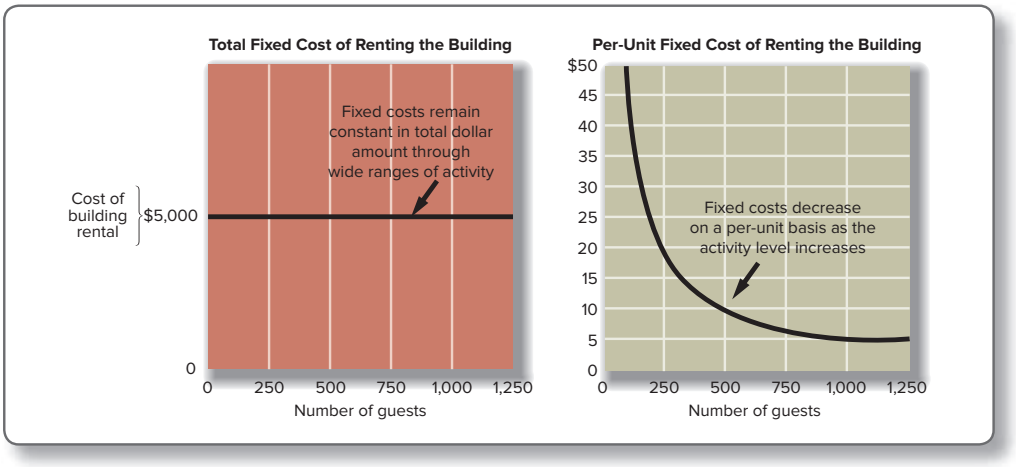


Fixed Costs

LO1 • **Know**
CC3: Describe the behaviour of fixed costs.

In our discussion of cost behaviour patterns in Chapter 2, we stated that fixed costs remain constant in total dollar amount within the relevant range of activity. To continue the 50 Plus Expeditions example, assume the company decides to rent a building for $5,000 per month to store its equipment. 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. This cost behaviour pattern is shown graphically in Exhibit 6–5.

EXHIBIT 6–5
Fixed Cost Behaviour



Since fixed costs remain constant in total, the amount of fixed costs computed on a *per-unit* basis becomes progressively smaller as the level of activity increases. If 50 Plus Expeditions has only 250 guests in a month, the $5,000 fixed rental cost will amount to $20 per guest. If there are 1,000 guests, the fixed rental cost will amount to only $5 per guest. This aspect of the behaviour of fixed costs is also displayed in Exhibit 6–5. Observe that as the number of guests increases, the average unit cost drops, but it drops at a decreasing rate. The first guests have the biggest impact on unit costs.

Fixed costs are sometimes expressed on a per-unit basis (i.e., unitized). In such situations, users of the information must be cautioned that fixed costs have been unitized and should not be mistaken for variable costs. For example, if Pizza Pizza allocates building rent at $0.25 per pizza, this does not mean that rent cost will increase by $0.25 every time a pizza is served. The amount of $0.25 per pizza is simply an average cost based on a certain volume of pizzas served and really has no meaning for decision-making purposes. This amount is allocated so that managers understand that the total cost of a pizza is *more than* the sum of all the variable costs. From a decision-making angle, this information can be useful for pricing purposes; from an analysis perspective, total cost information is useful for understanding profitability.

IN BUSINESS

MULTIPLE STRATEGIES TO FOSTER GROWTH AND ADDRESS COSTS

How should businesses deal with uncertainty and the related risks? This question is relevant to senior executives in both large and small businesses across the globe. According to a survey of 495 owners/executives of small and medium Canadian manufacturers, respondents are mostly optimistic about business prospects in the coming three years; yet, they are also aware of the risks and the need to develop strategies to address growth and manage costs. A key growth strategy is investment in machinery, equipment and technology, training, research and development (R&D), and productivity improvements. Managing costs, according to a global survey of over 1,000 executives in large corporations, requires a variety of strategies, one of which is digital technologies (such as artificial intelligence and robotics) that automate manual systems and processes, often resulting in significant long-term cost savings and quality improvements. It is important to recognize that investments in machinery, R&D, and technologies often require large outlays of cash and contribute toward increasing the fixed costs of a business.

Types of Fixed Costs

LO1 • **Know**

CC4: Explain committed and discretionary fixed costs.

Fixed costs are sometimes referred to as *capacity costs,* since they result from outlays made for buildings, equipment, skilled professional employees, and other items needed to provide the basic capacity for sustained operations. For planning purposes, fixed costs can be viewed as being either *committed* or *discretionary*.

COMMITTED FIXED COSTS **Committed fixed costs** relate to the investment in facilities, equipment, and the basic organizational structure of a firm. Examples include depreciation of buildings and equipment, taxes on real estate, insurance, and salaries of key personnel.

Committed fixed costs are long-term in nature and cannot be reduced to zero even for short periods without seriously impairing the profitability or long-term goals of the organization. Even if operations are interrupted or cut back, the committed fixed costs will still continue largely unchanged. During a recession, for example, a firm will not usually discharge key executives or sell off key facilities. The basic organizational structure and facilities are generally kept intact. The costs of restoring them later are likely to be far greater than any short-term savings that might be realized. Since it is difficult to change a committed fixed cost once the commitment has been made, management should approach these decisions with particular care. Management should make such commitments only after careful analysis of the available alternatives.

DISCRETIONARY FIXED COSTS **Discretionary fixed costs** (often referred to as *managed fixed costs*) usually arise from *annual* decisions by management to spend in certain areas. Examples of discretionary fixed costs include advertising, research, public relations, management development programs, management retreats, and internships for students.

Basically, two key differences exist between discretionary fixed costs and committed fixed costs. First, the planning horizon for a discretionary fixed cost is short—usually a single year. By contrast, committed fixed costs have a longer planning horizon. Second, discretionary fixed costs can be cut for short periods with minimal damage to the long-term goals of the organization. For example, spending on management retreats can be cut back because of poor economic conditions.

Whether a particular cost is regarded as committed or discretionary may depend on management's strategy. For example, during recessions when the level of home building is down, some construction companies lay most of their workers off and virtually disband operations. Other construction companies retain large numbers of employees on the payroll, even though the workers have little or no work to do. While these latter companies may be faced with short-term cash flow problems, it will be easier for them to respond quickly when economic conditions improve. The improved morale and loyalty of their employees may also give these companies a significant competitive advantage.

The most important characteristic of discretionary fixed costs is that management is not locked into a decision regarding such costs. The costs can be adjusted from year to year, or even perhaps during the course of a year, if circumstances demand such a modification.

HELPFUL HINT

Committed fixed costs are those that organizations (or individuals) are committed to for a period of time, whereas discretionary fixed costs are those for which no such commitments exist. As an example, an individual who enters into a rental agreement is committed to paying the monthly rent. In contrast, going to see a movie or buying an additional pair of shoes is more likely a discretionary expense (i.e., there is no commitment of any sort to incur these expenses).

THE TREND TOWARD FIXED COSTS The trend in many industries is toward greater fixed costs relative to variable costs. Chores that used to be performed manually have been taken over by machines. For example, an H&R Block employee used to fill out tax returns for customers by hand, and the advice given to a customer largely depended on the knowledge of that particular employee. Now, sophisticated computer software is used to complete tax returns, and the software provides the customer with tax planning and other advice tailored to the customer's needs on the basis of the accumulated knowledge of many experts. The move toward online banking and shopping has also necessitated more investment in technology and the required support structure.

As machines take over more and more of the tasks that used to be performed by humans, the overall demand for human workers has not diminished. The demand for *knowledge workers,* those who work primarily with their minds rather than their muscles, has grown tremendously. Knowledge workers tend to be salaried, highly trained, and difficult to replace. As a consequence, the costs of compensating knowledge workers are often relatively fixed and are committed, rather than discretionary.

IS LABOUR A VARIABLE COST OR A FIXED COST? As the preceding discussion suggests, wages and salaries may be fixed or variable. The behaviour of wage and salary costs will differ from one country to another, depending on labour regulations, labour contracts, and custom. In some countries, such as France, Germany, China, and Japan, management has little flexibility in adjusting the labour force to changes in business activity. In such countries as Canada, management typically has much greater latitude. However, even in less restrictive environments, managers may choose to treat employee compensation as a fixed cost.

Classifying direct labour as variable or fixed really depends on the employment terms and how employees are paid. If wages are paid strictly on the basis of the volume of output, then direct labour is truly a variable cost. However, in many organizations (including those that are unionized), direct labour

is paid either a weekly or a monthly salary. On top of that, employees may receive incentive compensation in the form of performance-based bonuses, provided they achieve predetermined output targets. In situations like this, direct labour cost is more likely fixed.

Many major organizations have undergone waves of downsizing in recent years, in which large numbers of employees—particularly middle managers—have lost their jobs. This downsizing might seem to prove that even management salaries should be regarded as variable costs, but this would not be a valid conclusion. Downsizing has been the result of attempts to automate and/or reengineer business processes and cut costs, rather than a response to a decline in sales activity. This underscores an important, but subtle, point: Fixed costs can change—they just do not change in response to small changes in activity.

In summary, we cannot provide a clear-cut answer to the question, "Is labour a variable or fixed cost?" It depends on how much flexibility management has and on management's strategy. *Nevertheless, we will assume in this text that unless otherwise stated, direct labour is a variable cost.*

IN BUSINESS

AIRLINES FACE INCREASING COSTS

Rising costs are a concern to the entire airline industry and one significant cost item is salaries and benefits. Over the years, WestJet's labour costs have increased by almost 50%. This and the increasing maintenance costs due to its aging fleet have resulted in a tighter cost situation for the airline. Through the involvement of labour unions in the industry, these challenges have only intensified. WestJet's American counterpart—American Airlines Group Inc.—was seeing a higher increase in labour costs in 2015 due to its two agreements with union groups: a $200 million increase in pay for flight attendants, and a potential $650 million increase in labour costs from proposed contracts with pilots.

An important outcome of the cost increase is that WestJet's earnings before income taxes steadily declined as a percentage of sales revenues over the past four years and particularly so in 2017 and 2018 (8.8% in 2017 and only 2.9% in 2018). An interesting trend was the decline in closing stock prices during 2018 ($24.61 down to $18.00).

Fixed Costs and the Relevant Range

LO1 • **Know**

CC5: Explain the importance of relevant range in understanding fixed costs.

The concept of relevant range, introduced in the discussion of variable costs, is also important in understanding fixed costs. The relevant range of activity for a fixed cost is the range of activity over which the graph of the cost is flat, as shown in Exhibit 6–6. As a company expands its level of activity, it may outgrow its present facilities, or the key management team may need to be expanded. The result,

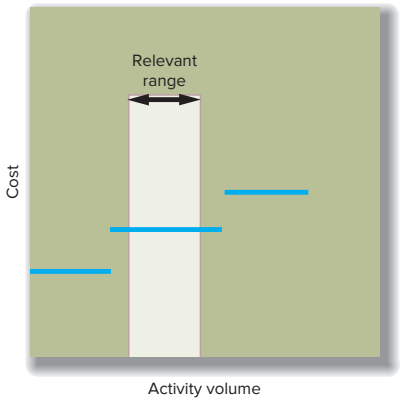


EXHIBIT 6–6
Fixed Costs and the Relevant Range

of course, will be increased committed fixed costs as larger facilities are built and as new management positions are created. For example, if Pizza Pizza doubles its capacity, more space, additional equipment, and more people will be required.

One reaction to the step pattern depicted in Exhibit 6–6 is to say that fixed costs are really just step-variable costs. To some extent, this is true, since almost *all* costs can be adjusted in the long run. There are two major differences, however, between the step-variable costs depicted in Exhibit 6–3 and the fixed costs depicted in Exhibit 6–6.

The first difference is that the step-variable costs can often be adjusted quickly as conditions change, whereas once fixed costs have been set they often cannot be changed easily. A step-variable cost, such as the cost of employing waiters, can be adjusted upward or downward by hiring and laying waiters off. In contrast, once an organization has signed a lease for a building, it is locked into that level of lease cost for the life of the contract.

The second difference is that the *width of the steps* depicted for step-variable costs is much narrower than the width of the steps depicted for the fixed costs in Exhibit 6–6. The width of the steps relates to volume or level of activity. For step-variable costs, the width of a step might be 40 hours of activity or fewer for clerical labour cost. For fixed costs, however, the width of a step might be *thousands* or even *tens of thousands* of hours of activity. In essence, the width of the steps for step-variable costs is generally so narrow that these costs can be treated essentially as variable costs for most purposes. The width of the steps for fixed costs, in contrast, is large enough that these costs must generally be treated as entirely fixed within the relevant range.

IN BUSINESS

MANAGING SALES AND MARKETING

CEL Packaging Pvt. Limited is based in western India and provides total packaging solutions to its customers. As every organization does, CEL has been finding ways to reduce costs across various functions. A thorough cost analysis suggested that there was some scope for reducing sales and marketing costs by at least 25%. After additional analysis, CEL decided to close its sales offices in some locations and employ sales agents on a commission basis. As a result, the company eliminated the large fixed costs of maintaining sales offices. It now incurs only variable costs by way of commissions paid to the sales agents on the basis of sales revenues. (CEL uses the Indian rupee (₹) as its base currency, and $1 = ₹50 at the time of writing.) CEL saved about ₹23,000 per month on sales of ₹200,000, which translated into a reduction of about 31%. CEL has not stopped its cost reduction efforts with these savings; instead, it continues to find other areas where costs can be saved.

Mixed Costs

LO1 • Know

CC6: Describe the behaviour of mixed costs.

LO2 • Apply • Know

CC7: Construct a basic linear cost equation, and explain the individual elements of the cost equation.

A **mixed cost** is one that contains both variable and fixed cost elements. To continue the 50 Plus Expeditions example, assume that the company must pay a licence fee of $25,000 per year plus $3 per rafting party to provincial authorities. If the company runs 1,000 rafting parties this year, then the total fees paid to the province will be $28,000, made up of $25,000 in fixed cost plus $3,000 in variable cost. The behaviour of this mixed cost is shown graphically in Exhibit 6–7.

Even if 50 Plus fails to attract any customers, the company will still have to pay the licence fee of $25,000. This is why the cost line in Exhibit 6–7 intersects the vertical cost axis at the $25,000 point. For each rafting party the company organizes, the total cost of the provincial fees will increase by $3. Therefore, the total cost line slopes upward as the variable cost element is added to the fixed cost element.

Since the mixed cost in Exhibit 6–7 is represented by a straight line, the following equation for a straight line can be used to express the relationship between mixed cost and the volume of activity:

$$Y = a + bX$$

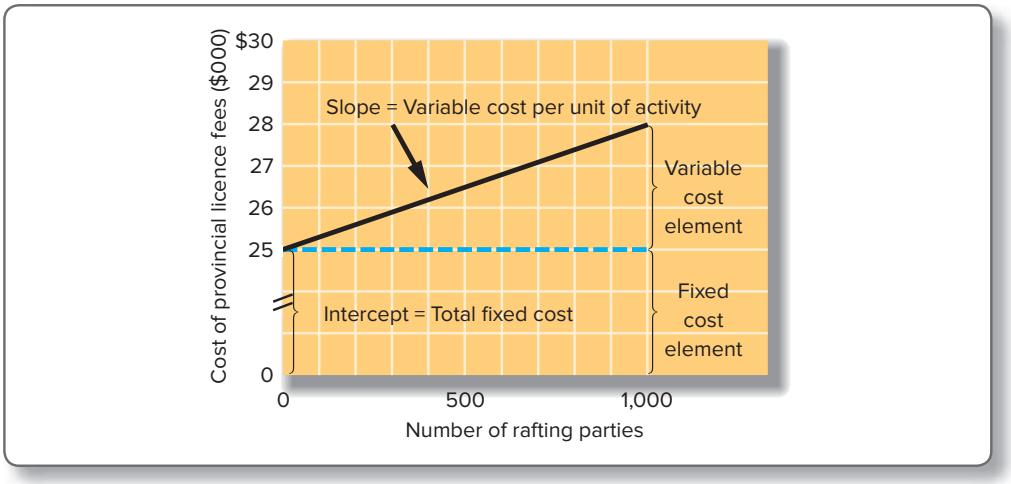


EXHIBIT 6–7
Mixed Cost Behaviour

In this equation,

Y = Total mixed cost
a = Total fixed cost (the vertical intercept of the line)
b = Variable cost per unit of activity (the slope of the line)
X = Level of activity

In the case of the provincial fees paid by 50 Plus Expeditions, the equation is written as follows:

Y	=	\$25,000	+	\$3.00	×	X
Total mixed cost		Total fixed cost		Variable cost per unit of activity		Activity Volume

This equation makes it easy to calculate the total mixed cost for any volume of activity within the relevant range. For example, suppose that the company expects to organize 800 rafting parties in the next year. The total fees would be \$27,400, calculated as follows:

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

Note that we have presented a rather simplistic linear cost equation; cost patterns can certainly be more complicated.

A mixed cost expressed on a per-unit basis decreases as the activity level increases. Do you know why? On a per-unit basis as the activity level increases, although the variable portion of a mixed cost stays constant, the fixed portion of a mixed cost decreases. This occurs because the fixed cost is being spread across more units.

HELPFUL HINT

2. Which of the following statements are false? (You may select more than one answer.)
   a. The planning horizon for discretionary fixed costs is longer than the planning horizon for committed fixed costs.
   b. Discretionary fixed costs can be cut in the short term if necessary, while committed fixed costs cannot be cut for short periods.
   c. As companies increasingly rely on knowledge workers, the labour cost associated with employing these workers is often committed fixed as opposed to discretionary.
   d. A mixed cost contains both committed fixed and discretionary elements.

*Note to student: See **Guidance Answers** online.*

CONCEPT CHECK

The Analysis of Mixed Costs

LO2 • **Know**

CC8: Explain the importance of separating mixed costs into fixed and variable portions.

In practice, mixed costs are quite common. For example, the cost of providing X-ray services to patients at the Toronto General Hospital is a mixed cost. There are substantial fixed costs for equipment depreciation and for salaries of radiologists and technicians, but there are also variable costs for X-ray film, power, and supplies. At WestJet Airlines, maintenance costs are mixed costs. The company must incur fixed costs for renting maintenance facilities and for keeping skilled mechanics on the payroll, but the costs of replacement parts, lubricating oils, tires, and so on are variable with respect to how often and how far the company's aircraft are flown.

The fixed portion of a mixed cost represents the basic, minimum cost of just having a service *ready and available* for use (i.e., capacity cost). The variable portion represents the cost incurred for *actual consumption* of the service. The variable element varies in proportion to the amount of service consumed.

Why should management be interested in separating the fixed and variable portions of a mixed cost? The simple answer is that a mixed cost is a combination of two cost types with exactly opposite behaviours. While one cost type varies in proportion to changes in activity volume, the other type does not. Therefore, when activity volume changes within the organization, only the variable portion of the mixed cost will be affected (in terms of total cost going up or down). Approximating a mixed cost to one or the other will distort planning and decision making. For example, budgeting is an important activity in most organizations and requires a good understanding of cost behaviour. Managers who are unable to separate variable costs from fixed costs will not be able to make accurate predictions of future costs—this is not a desirable situation.

Now we know why separating the fixed and variable portions is important, but how does management go about estimating the fixed and variable elements? That really depends on the availability of historical data to guide the process. *Account analysis* and the *engineering approach* are commonly used when there is little or no historical data available for analysis. However, when a considerable amount of historical data is available, managers can choose from the following three methods: *high–low, scattergraph,* and *regression analysis*.

Nonquantitative Approaches to Cost Analysis

In **account analysis**, each account under consideration is classified as either variable or fixed on the basis of the analyst's knowledge of how the cost in the account behaves. For example, direct materials would be classified as variable, and a building lease cost would be classified as fixed, because of the nature of those costs.

Account analysis works best when analyzing costs at a fairly aggregated level, such as the cost of serving patients in the emergency room (ER) of your local hospital. The costs of drugs, supplies, forms, wages, equipment, and so on can be roughly classified as variable or fixed, with respect to the number of patients, and a mixed cost formula for the overall cost of the ER can be estimated fairly quickly.

The **engineering approach** to cost analysis involves a detailed analysis of what the cost behaviour should be, based on an industrial engineer's evaluation of the production methods to be used, the materials specifications, labour requirements, equipment usage, efficiency of production, power consumption, and so on. For example, Pizza Hut might use the engineering approach to estimate the cost of serving a particular takeout pizza. Once we know the types of resources required, we can attempt to classify them as fixed or variable.

Quantitative Approaches to Cost Analysis

This section will focus on how to separate fixed and variable costs using quantitative methods. We do this using the example presented at the beginning of this chapter (see Managerial Accounting in Action).

We will examine three methods that Kinh Nguyen could use to break mixed costs down into their fixed and variable elements—the *high–low method,* the *scattergraph method,* and the *least-squares regression method.* All three methods are based on analyzing historical cost and activity data. In the case of Mid-Town Medical Centre (MMC), we will use the following records of

maintenance costs and patient-days for the previous year to estimate the fixed and variable elements of maintenance costs:

Month	Activity Volume (patient-days)	Maintenance Cost Incurred
January	5,600	$7,900
February	7,100	8,500
March	5,000	7,450
April	6,500	8,200
May	7,300	9,070
June	8,000	9,800
July	6,200	7,800
August	7,200	8,600
September	6,100	8,000
October	5,900	7,950
November	6,200	8,120
December	5,800	7,970

The High–Low Method

LO2 • Know • Apply

CC9: Describe the high–low method of analyzing mixed costs, and set up a cost equation using this method.

To analyze mixed costs with the **high–low method**, begin by identifying the period with the lowest level of activity (March) and the period with the highest level of activity (June). The difference in cost corresponding to the two extreme activity levels is divided by the difference between the high and low activity levels to estimate the variable cost per unit of activity (the calculation is shown below).

	Patient-Days	Maintenance Cost Incurred
High activity level (June)	8,000	$9,800
Low activity level (March)	5,000	7,450
Change	3,000	$2,350

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$9{,}800 - \$7{,}450}{8{,}000 - 5{,}000} = \frac{\$2{,}350}{3{,}000 \text{ patient-days}} = \$0.783 \text{ per patient-day}$$

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 that follows, total cost at the high activity level is used in computing the fixed cost element:

$$\begin{aligned}\text{Fixed cost element} &= \text{Total cost} - \text{Variable cost element}\\ &= \$9{,}800 - (\$0.783 \text{ per patient-day} \times 8{,}000 \text{ patient-days})\\ &= \$3{,}536\end{aligned}$$

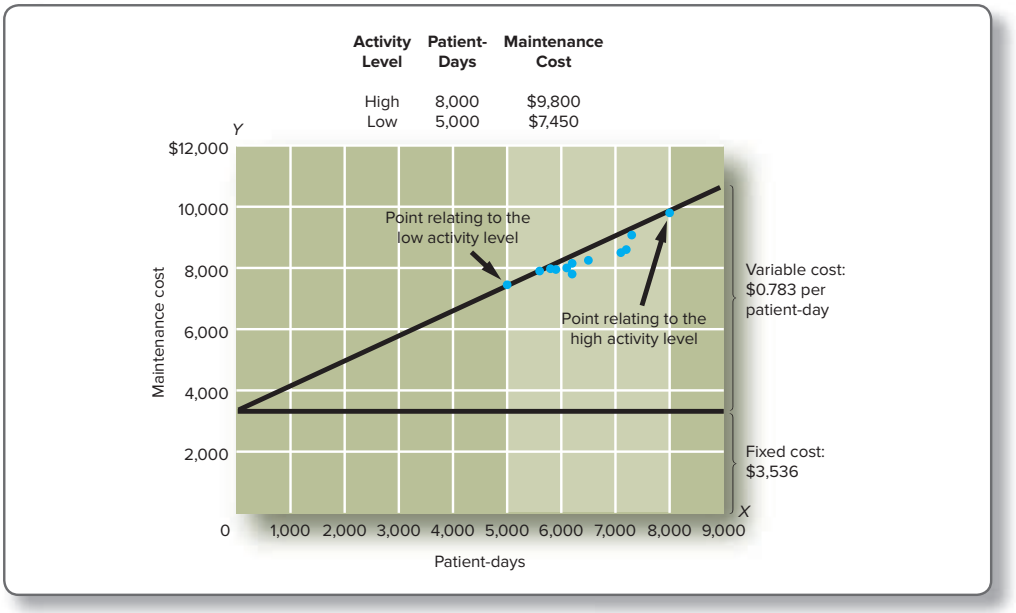
Both the variable and fixed cost elements have now been isolated. The cost of maintenance can be expressed as $3,536 per month plus 78.3 cents per patient-day.

The cost of maintenance can also be expressed in terms of the equation for a straight line as follows:

$$Y = \$3{,}536 + \$0.783X$$

Total maintenance cost — Number of patient-days

EXHIBIT 6–8
High–Low Method of Cost Analysis



The data used in this illustration are shown graphically in Exhibit 6–8. Three things should be noted in relation to this exhibit:

1. The total maintenance cost, *Y*, is plotted on the vertical axis. Cost is known as the **dependent variable**, since the amount of cost incurred during a period depends on the volume of activity for the period. (That is, as the volume of activity increases, total cost will also increase.)
2. The activity, *X* (patient-days in this case), is plotted on the horizontal axis. Activity is known as the **independent variable**, since it causes variations in the cost.
3. A straight line has been drawn through the two points corresponding to the low and high levels of activity. (The formula for the variable cost is the same as the formula for the slope of the line.) It is important to note that by drawing a straight line we are assuming linearity of costs. Managers must be made aware that approximating a cost formula to a linear function may result in a misstatement of costs.

Sometimes, the high and low levels of activity *do not coincide* with the high and low amounts of cost. For example, the period that has the highest level of activity might not have the highest amount of cost. Nevertheless, the highest and lowest levels of *activity* and the costs *corresponding* to these two activity levels are used to analyze a mixed cost under the high–low method. The activity is the independent variable (i.e., the factor that presumably causes costs); therefore, the analyst would like to use data that reflect the greatest possible variation in activity.

WORKING IT OUT

Assume a hotel rented 400, 480, and 420 rooms in the months of April, May, and June, respectively; the total housekeeping costs for the three months in question were $6,000, $6,800, and $6,200.

Required:

Using the high–low method, what is the amount of monthly fixed housekeeping costs?

SOLUTION TO WORKING IT OUT

We use the following five-step process to perform the high–low method calculations:

Step 1: Select the two periods with the highest and lowest levels of activity. In our question, the highest level of activity occurs in May and the lowest level of activity occurs in April.

Step 2: Compute the change in cost and the change in activity between the two periods. The activity levels and corresponding costs in those two months are 480 rooms and $6,800, and 400 rooms and $6,000, respectively. Therefore, the change in cost is $800 and the change in activity level is 80.

Step 3: Divide the change in cost by the change in activity to derive your estimate of the variable cost per unit.

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$6{,}800 - \$6{,}000}{480 - 400} = \$10 \text{ per room}$$

Step 4: Multiply the low (or high) level of activity by the variable cost per unit. Subtract this amount from the total cost at the low (or high) level of activity to derive the fixed portion of the mixed cost.

Total variable cost at the low level of activity = 400 rooms × $10 per room = $4,000

Therefore,

Fixed cost = $6,000 − $4,000 = $2,000

Step 5: Use the equation $Y = a + bX$ to estimate the total mixed cost for any level of activity within the relevant range.

Cost equation is as follows: $Y = \$2{,}000 + \$10X$, where

Y = Monthly housekeeping costs

X = Number of rooms

The Scattergraph Method

LO2 • Know • Apply

CC10: Explain the scattergraph method of analyzing mixed costs, and set up a cost equation using this method.

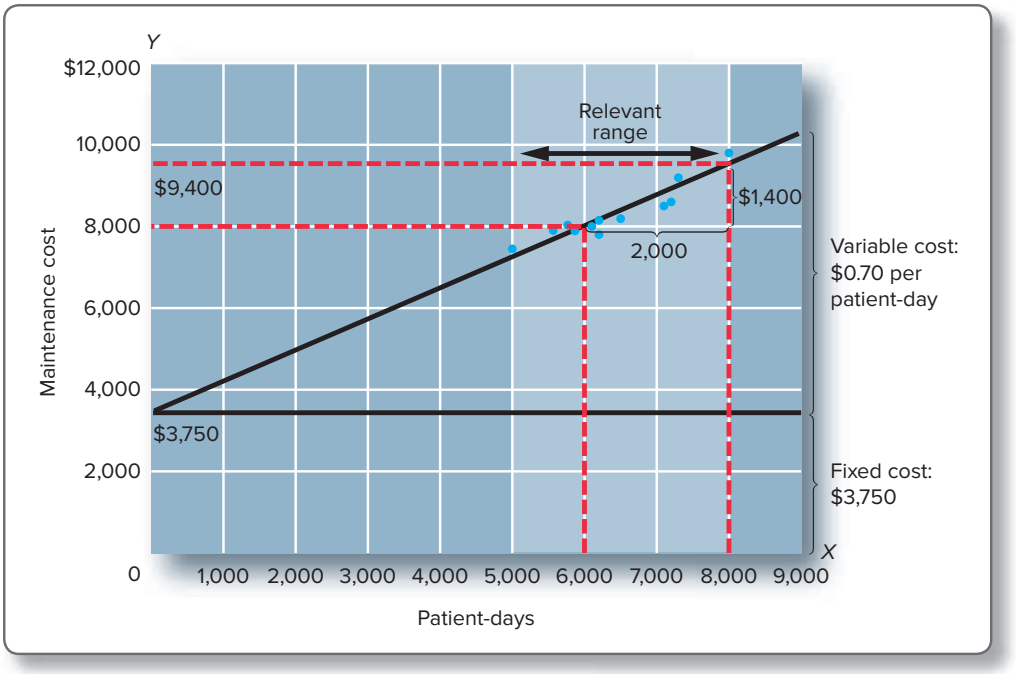
A more accurate method of analyzing mixed costs is the **scattergraph method**, which takes into account all of the activity volume and cost data. A graph like the one that we used in Exhibit 6–8 is constructed, in which costs observed at various levels of activity are plotted and a line is fitted to the plotted points. However, rather than just fitting the line to the high and low points, all points are considered when the line is drawn. This is done through simple visual inspection of the data, with the analyst taking care that the line is representative of all points, not just the high and low ones. Typically, the line is drawn such that approximately equal numbers of points fall above and below it. A graph of this type is known as a *scattergraph,* and the line *fitted* to the plotted points is known as a **regression line**.

The scattergraph approach using the MMC maintenance data is illustrated in Exhibit 6–9. Note that the regression line has been placed in such a way that approximately equal numbers of points fall above and below it. Since the regression line intersects the vertical cost axis at $3,750, this amount represents the fixed cost element.

The variable cost element can be computed by determining the slope of the regression line, *within the relevant range,* which can be done as follows. First, select any two activity levels on the *X*-axis that lie within the relevant range of 5,000 to 8,000 patient-days; we have selected 6,000 and 8,000 patient-days. Next, draw vertical lines from these two activity levels to intersect the regression line. From the two points where the just-drawn vertical lines intersect the regression line, draw horizontal lines to the *Y*-axis. Note that the horizontal line corresponding to the 8,000-patient-day activity level intersects the *Y*-axis at the $9,400 cost level, whereas the horizontal line corresponding to the 6,000-patient-day activity level intersects the *Y*-axis at the $8,000 cost level. We capture these two data points as follows:

	Patient-Days	Maintenance Cost Incurred
Activity level 1	8,000	$9,400
Activity level 2	6,000	8,000
Change	2,000	$1,400

EXHIBIT 6–9
Scattergraph Method of Cost Analysis



It is important to note that the amount of $9,400 shown in the table above is different from $9,800 as mentioned in the data table. This is because the amounts shown in the data table are actual recorded amounts, whereas the amounts shown in the table above are estimates based on the graph shown in Exhibit 6–9. *These estimated amounts can change depending upon the slope of the line that the analyst draws.*

We now use the same method that we used in the high–low method to calculate the slope of the line or the variable cost, which will result in a variable cost of $0.70 per patient-day.

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$1{,}400}{2{,}000 \text{ patient-days}} = \$0.70 \text{ per patient-day}$$

Thus, the cost formula using the regression line in Exhibit 6–9 would be $3,750 per month plus 70 cents per patient-day. In terms of the linear equation $Y = a + bX$, the cost formula can be written as follows:

$$Y = \$3{,}750 + \$0.70X$$

where activity (X) is expressed in patient-days.

In this example, there is not a great deal of difference between the cost formula derived using the high–low method and the cost formula derived using the scattergraph method (only 8.3 cents per patient-day). However, sometimes, there *could* be a big difference. In such situations, more reliance should ordinarily be placed on the results of the scattergraph approach.

Also, observe that all of the points in Exhibit 6–9 lie reasonably close to the straight line. In other words, the estimates of the fixed and variable costs are reasonably accurate within this range of activity, and so the relevant range extends at least from 5,000 to 8,000 patient-days. It may also be accurate below 5,000 patient-days and above 8,000 patient-days—we cannot tell for sure without looking at more data. *If the activity level consistently falls below 5,000 patient-days, it may be possible for MMC to reduce the level of fixed costs. Similarly, if the activity level consistently increases above 8,000 patient-days, MMC may have to increase its level of fixed costs. Both these situations will result in new cost formulas.*

LO2 • Know • Apply

CC11: Explain the least-squares regression method of analyzing mixed costs, and set up a cost equation using this method.

The Least-Squares Regression Method

The basic idea underlying the **least-squares regression** method is illustrated in Exhibit 6–10 using hypothetical data points. Note that the deviations from the plotted points to the regression line are measured vertically on the graph. These vertical deviations, called the *regression errors,* are the key

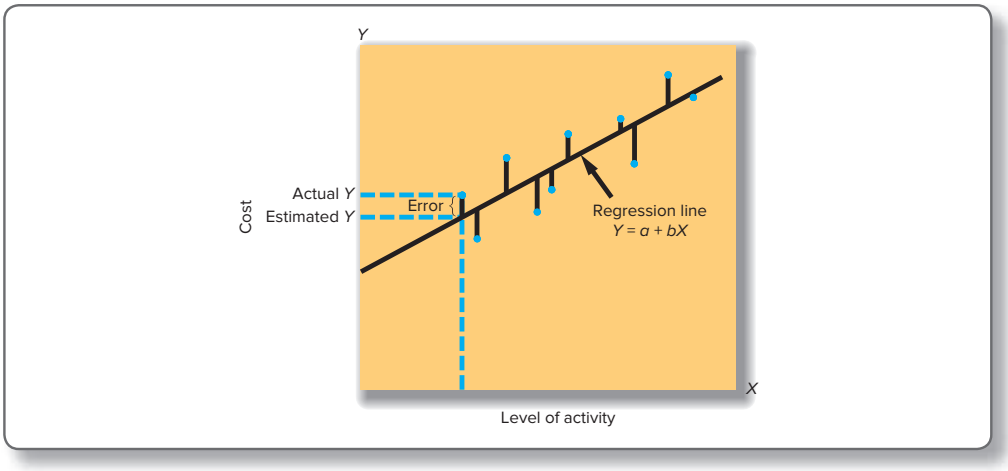


EXHIBIT 6–10
The Concept of Least-Squares Regression

to understanding least-squares regression. There is nothing mysterious about the least-squares regression method. It simply computes the regression line that minimizes the sum of these squared errors. The formulas that accomplish this are fairly complex and involve numerous calculations, but the principle is simple.

Using Excel to Do Regression Analysis

Basic regression analysis can be done using the following simple steps in Excel.

1. Enter data for the *Y* (dependent) variable and the *X* (independent) variable in two separate columns.
2. Click on the Data tab in Excel.
3. In the Data menu, click on Data Analysis, which appears on the far right.
4. Scroll down the Data Analysis menu and click on Regression.
5. Enter the data range for the *Y* and the *X* variables (e.g., A3:A15).
6. Enter the range where you want the output to be displayed (e.g., A31:H50).
7. Click OK; results will be displayed in the output range specified.

Results from a regression analysis of MMC's maintenance cost data will appear as follows:

	A	B	C	D	E	F	G	H	I
1	*Regression Statistics*								
2	Multiple R	0.939225444							
3	R Square	0.882144434							
4	Adjusted R Square	0.870358877							
5	Standard Error	229.3805547							
6	Observations	12							
7									
8	ANOVA								
9		*df*	*SS*	*MS*	*F*	*Significance F*			
10	Regression	1	3938245.611	3938246	74.84962	5.89323E-06			
11	Residual	10	526154.3889	52615.44					
12	Total	11	4464400						
13									
14		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
15	Intercept	3752.265765	527.5150675	7.113097	3.24E-05	2576.888948	4927.642582	2576.888948	4927.642582
16	X Variable 1	0.706538502	0.081665953	8.651567	5.89E-06	0.52457542	0.888501584	0.52457542	0.888501584

The intercept term (3,752) represents the fixed cost per month, whereas the coefficient for the X variable 1 (0.707) represents the slope of the regression line—which is also the variable cost per patient-day. Therefore, using the least-squares regression method, the cost equation can be written as

$$Y = \$3{,}752 + \$0.707\,X$$

where activity (X) is expressed in patient-days.

One very important statistic generated as part of the regression analysis is R square (R^2). The R^2 in this example is 0.88 or 88%. This simply means that 88% of the variation in maintenance costs is explained by the variation in patient-days. In other words, only 12% of the variation in maintenance cost is not explained by the variation in patient-days. Knowing this helps the managers to decide whether the cost estimates have been developed on a reliable basis (e.g., patient-days). In other words, if the R^2 is low, the manager must look for some other base to estimate costs.

Comparing the Three Methods

Which of the three methods is most useful? Exhibit 6–11 compares the three methods.

EXHIBIT 6–11
Comparison of the Three Methods of Cost Data Analysis

Method	Advantages	Limitations
High–low	It is easy to understand and apply.	It utilizes only two points in the analysis; these could be abnormal observations. The cost formula may seriously misrepresent the true cost relationship that holds during normal periods.
Scattergraph	It can be an extremely useful tool in the hands of an experienced analyst. Quirks in cost behaviour due to strikes, bad weather, breakdowns, and so on become immediately apparent to the trained observer.	The line drawn is subjective. No two analysts who look at the same scattergraph are likely to draw exactly the same regression line. The cost estimates are not as precise as they are with other more sophisticated methods.
Least-squares regression	It is an objective and precise approach. It uses all data points in the analysis. It mathematically fits the regression line. It provides other useful statistics (e.g., R^2). Analysis can be done using computer software.	

MANAGERIAL ACCOUNTING IN ACTION

THE WRAP-UP

After completing the analysis of maintenance costs, Kinh Nguyen met with Dr. Derek Chalmers to discuss the results.

MID-TOWN MEDICAL CENTRE

Nguyen: We used least-squares regression analysis to estimate the fixed and variable components of maintenance costs. According to the results, the fixed cost per month is $3,752, and the variable cost per patient-day is 70.7 cents.

Chalmers: Okay, so if we plan for 7,800 patient-days next month, what is your estimate of the maintenance costs?

Nguyen: That will take just a few seconds to figure out. [He wrote the following calculations on a pad of paper.]

Fixed costs	$3,752
Variable costs:	
7,800 patient-days × $0.707 per patient-day	5,515
Total expected maintenance costs	$9,267

Chalmers: Nine thousand two hundred sixty-seven dollars . . . isn't that a bit *too* precise?

Nguyen: Sure. I don't really believe the maintenance costs will be exactly this figure. However, on the basis of the information we have, this is the best estimate we can come up with.

Chalmers: Don't let me give you a hard time. Even though it is an estimate, it will be a lot better than just guessing like we have done in the past. It will surely help us in our budgeting efforts. Thanks. I hope to see more of this kind of analysis.

ENTREPRENEUR

You are the owner of a small manufacturing firm. You are thinking about expanding your production capacity and are wondering about the implications of this on your costs. You therefore need a better understanding of your costs. How do you proceed?

Note to student: See ***Guidance Answers*** *online.*

DECISION POINT

Contribution Margin

What do you do after separating costs on the basis of behaviour? We have already partially answered this question by saying that this separation can be used to estimate costs. Another important use of the separation of costs into fixed and variable is that managers can use the information to compute the contribution margin and prepare a contribution margin income statement (see Exhibit 6–12), which is different from the traditional income statement presented in Chapter 2. **Contribution margin** is the difference between sales revenues and all variable costs based on an output measure of activity; it is the amount remaining once all the variable costs have been deducted from sales revenues.

The unique thing about the contribution margin approach is that it provides managers with an income statement that clearly distinguishes between fixed and variable costs, and therefore aids planning and decision making. For example, a merchandising company will price its product in such a way that it covers all its costs and earns a certain level of income. However, competitive pressures may force it to drop its price for a short period, at which time management will want to ensure that the lower price covers at least the variable costs. We will revisit the concepts of variable and fixed costs and contribution margin in later chapters.

LO3 • Know • Apply

CC12: Explain the concept of contribution margin, and prepare a contribution margin income statement.

EXHIBIT 6–12 Traditional and Contribution Margin Income Statements for a Merchandising Company (all numbers given)

Traditional Format			Contribution Format		
Sales		$12,000	Sales		$12,000
Cost of goods sold*		6,000	Variable expenses:		
Gross margin		6,000	Cost of goods sold	$6,000	
Selling and administrative expenses:			Variable selling	600	
Selling	$3,100		Variable administrative	400	7,000
Administrative	1,900	5,000	Contribution margin		5,000
Net operating income		$ 1,000	Fixed expenses:		
			Fixed selling	2,500	
			Fixed administrative	1,500	4,000
			Net operating income		$ 1,000

*For a manufacturing company, the cost of goods sold would include some variable costs, such as direct materials, direct labour, and variable overhead, and some fixed costs, such as fixed manufacturing overhead.

CONCEPT CHECK

3. A company's contribution margin income statement showed net operating income of $4,000 and fixed expenses of $10,000. How much contribution margin did the company earn?
   a. $29,000
   b. $15,000
   c. $19,000
   d. $14,000

Note to student: See ***Guidance Answers*** *online.*

Learning Objectives Summary

LO1 UNDERSTAND COST BEHAVIOUR.

Understanding cost behaviour is important for planning, decision making, and reporting. A variable cost varies in direct proportion to changes in activity. A step-variable cost increases or decreases only in more than a unit change in activity. A fixed cost remains constant in total within a relevant range of activity (the range of activity for which assumptions about cost behaviour are valid). Two types of fixed costs exist: committed and discretionary. A mixed cost is one that contains variable and fixed portions.

LO2 ANALYZE AND ESTIMATE COSTS.

A basic cost equation is written in terms of $Y = a + bX$, where Y is the total cost, a is the total fixed cost, b is the variable cost per unit of activity, and X is the activity level. Y is mixed in nature, and it is useful to separate the fixed and variable portions for the purposes of cost analysis and estimation. The most common quantitative methods used to analyze mixed costs are the high–low method, scattergraph method, and least-squares regression method.

LO3 COMPUTE CONTRIBUTION MARGIN AND INCOME.

Contribution margin is the difference between sales revenue and total variable costs. Companies often prepare a contribution margin income statement for internal use. Such a statement shows sales revenues, variable costs, contribution margin, fixed costs, and income. This income statement format is quite different from the traditional format, which does not separate costs by behaviour.

Application Competency Summary

APPLICATION COMPETENCY	DELIVERABLE	SOURCE DOCUMENTS AND KEY INFORMATION	STEPS	KNOWLEDGE COMPETENCY
Construct a basic linear cost equation. • **LO2–CC7**	*Key Information* Cost equation *Report/Document* No specific report Can be used in preparing other reports for planning and decision making (e.g., flexible budget performance report)	*Cost Records* Fixed portion of the total cost (constant term) Variable portion of the total cost (slope of the equation) Activity causing costs (independent variable)	1. Identify the fixed and variable portions of the cost, and express the cost equation in the form $Y = a + bX$	Mixed costs • **LO1–CC6**
Set up a cost equation using the high-low method. • **LO2–CC9**	*Key Information* Cost equation *Report/Document* No specific report Can be used in preparing other reports for planning and decision making (e.g., standard cost card)	*Historical Cost Records* Actual historical data of the volume of the independent variable (*X*-values) and the corresponding cost (*Y*-values) over a period (e.g., daily, weekly, monthly)	1. Identify the high and low observations of the independent variable and the corresponding costs associated with each observation. 2. Compute the slope (*b*) as follows: Divide the difference in the two cost numbers by the difference between the quantity of the high and low observations of the independent variable. 3. Compute the intercept (*a*) as follows: Multiply the slope by the high (or low) observation of the independent variable, and deduct this amount from the total cost corresponding to the independent variable. 4. Using the slope and the intercept, construct a cost equation to estimate future costs.	Mixed costs • **LO1–CC6** Elements of the cost equation • **LO2–CC7** High-low method • **LO2–CC9**
Set up a cost equation using the scattergraph method. • **LO2–CC10**	*Key Information* Cost equation *Report/Document* No specific report Can be used in preparing other reports for planning and decision-making situations (e.g., profitability report)	*Historical Cost Records* Actual historical data of the volume of the independent variable (*X*-values) and the corresponding cost (*Y*-values) over a period (e.g., daily, weekly, monthly)	1. Plot the data with the *X*-axis representing the independent variable and the *Y*-axis representing the cost. 2. Visually, draw a straight line that best fits the data through the points on the plot, and extend it to intersect the *Y*-axis. The above intersection point on the *Y*-axis represents the intercept (fixed portion) of the cost equation. 3. Draw vertical lines from any two points on the *X*-axis such that they intersect the *Y*-axis. Draw lines from the intersecting points on the line to the *Y*-axis. Compute the slope as follows: Divide the difference between the two points on the *Y*-axis by the difference between the two points on the *X*-axis. 4. Using the slope and the intercept, construct a cost equation to estimate future costs.	Mixed costs • **LO1–CC6** Elements of the cost equation • **LO2–CC7** Scattergraph method • **LO2–CC10**

APPLICATION COMPETENCY	DELIVERABLE	SOURCE DOCUMENTS AND KEY INFORMATION	STEPS	KNOWLEDGE COMPETENCY
Set up a cost equation using the least-squares regression method. • **LO2–CC11**	*Key Information* Cost equation *Report/Document* No specific report Can be used in preparing other reports for planning and decision-making situations (e.g., budget)	*Historical Cost Records* Actual historical data of the volume of the independent variable (*X*-values) and the corresponding cost (*Y*-values) over a period (e.g., daily, weekly, monthly)	1. Enter the data using statistics software or a spreadsheet, then run the least-squares regression method. 2. Identify the value of the slope and the intercept from the output generated by the software. 3. Using the slope and the intercept, construct a cost equation to estimate future costs.	Mixed costs • **LO1–CC6** Elements of the cost equation • **LO2–CC7** Least-squares regression technique • **LO2–CC11**
Prepare a contribution margin income statement. • **LO3–CC12**	*Key Information* Contribution margin and net income *Report/Document* Contribution margin income statement	*Sales Ledger* Actual sales revenue *Various Cost Ledgers* Actual variable and fixed costs	1. Obtain the sales revenue from the sales ledger and the variable and fixed costs from various cost ledgers. 2. Deduct all variable costs from sales revenues to compute the contribution margin, and deduct fixed costs to compute net income.	Variable and fixed costs • **LO1–CC1, 3** Mixed costs • **LO1–CC6** • **LO2–CC8**

Review Problem 1: Cost Behaviour

Neptune Rentals offers 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 behaviour patterns remain unchanged within the relevant range of 5,000 to 8,000 hours.

SOLUTION TO REVIEW PROBLEM 1

The variable cost per hour can be computed as follows:

$$\$20{,}000 \div 5{,}000 \text{ hours} = \$4 \text{ per hour}$$

Therefore, in accordance with the behaviour of variable and fixed costs, the missing amounts are as follows:

	Hours of Operating Time			
	5,000	6,000	7,000	8,000
Total costs:				
Variable costs	$ 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

Observe that the total variable costs increase in proportion to the number of hours of operating time but that these costs remain constant at $4 if expressed on a per-hour basis.

In contrast, the total fixed costs do not change with changes in the level of activity. They remain constant at $168,000 within the relevant range. With increases in activity, however, the fixed costs decrease on a per-hour basis, dropping from $33.60 per hour when the boats are operated 5,000 hours a period to only $21 per hour when the boats are operated 8,000 hours a period. *Because of this troublesome aspect of fixed costs, they are most easily (and most safely) dealt with on a total basis, rather than on a per-unit basis, in cost analysis work.*

Review Problem 2: High–Low Method

The manager of Golf Warehouse would like a cost formula linking the costs involved in processing orders to the number of orders received during a month. The order entry department's costs and the number of orders received during the immediately preceding eight months are given in the following table:

Month	Number of Orders Received	Order Entry Department Costs
May	1,000	$11,980
June	1,700	16,000
July	1,400	14,200
August	1,650	15,500
September	900	11,520
October	1,150	12,500
November	1,200	13,000
December	1,320	13,800

Required:

1. Use the high–low method to establish the fixed and variable components of order processing costs.
2. Express the fixed and variable components of order processing costs as a cost formula in the linear equation form $Y = a + bX$.

SOLUTION TO REVIEW PROBLEM 2

1. The first step in the high–low method is to identify the periods of the highest and lowest activity. Those periods are June (1,700 orders received) and September (900 orders received).

   The second step is to compute the variable cost per unit using those two points:

Month	Number of Orders Received	Order Entry Department Costs
High activity level (June)	1,700	$16,000
Low activity level (September)	900	11,520
Change	800	$ 4,480

$$\text{Variable cost} = \frac{\text{Change in cost}}{\text{Change in activity}} = \frac{\$4{,}480}{800 \text{ orders received}} = \$5.60 \text{ per order received}$$

   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 point of activity. In the computation below, the high point of activity is used:

$$\begin{aligned}\text{Fixed cost element} &= \text{Total cost} - \text{Variable cost element}\\ &= \$16{,}000 - (\$5.60 \text{ per order received} \times 1{,}700 \text{ orders received})\\ &= \$6{,}480 \text{ per month}\end{aligned}$$

2. The cost formula expressed in the linear equation form is $Y = \$6{,}480 + \$5.60X$.

Questions

6–1 Distinguish among (a) variable cost, (b) fixed cost, and (c) mixed cost.

6–2 What effect does an increase in activity volume have on
   a. Unit fixed costs?
   b. Unit variable costs?
   c. Total fixed costs?
   d. Total variable costs?

6–3 Define the following terms: (a) cost behaviour and (b) relevant range.

6–4 What is meant by an *activity base* when dealing with variable costs? Give several examples of activity bases.

6–5 Distinguish among (a) a variable cost, (b) a mixed cost, and (c) a step-variable cost. Chart the three costs on a graph, with activity plotted horizontally and cost plotted vertically.

6–6 Managers often assume a strictly linear relationship between cost and activity volume. How can this practice be defended in light of the fact that many cost relationships are curvilinear?

6–7 Distinguish between discretionary fixed costs and committed fixed costs.

6–8 Classify the following fixed costs as normally being either committed or discretionary:
   a. Depreciation on buildings.
   b. Advertising.
   c. Research.
   d. Long-term equipment leases.
   e. Pension payments to the firm's retirees.
   f. Management development and training.

6–9 Does the concept of the relevant range apply to fixed costs? Explain your answer.

6–10 What is the major disadvantage of the high–low method?

6–11 What methods are available for separating a mixed cost into its fixed and variable elements using past records of cost and activity data? Which method is considered to be most accurate? Why?

6–12 What is a regression line? Give the general formula for a regression line. Which term represents the variable cost? The fixed cost?

6–13 Once a regression line has been drawn, how do you determine the fixed cost element? The variable cost element?

6–14 What is least-squares regression?
6–15 Why is the least-squares regression method preferred to the high–low method when analyzing mixed costs?
6–16 What is the difference between the scattergraph method and the least-squares regression method?
6–17 "The higher the R^2 of a regression equation, the better the likelihood that X is an appropriate cost driver for Y." Is this true or false? Explain your answer.
6–18 What is the contribution margin?
6–19 What is the difference between the contribution margin approach to the income statement and the traditional approach to the income statement?

The Foundational 15

[LO1 – CC1, 3, 6; LO2 – CC7, 9; LO3 – CC12]

Consider the following data for Magnimus Corporation.

	July	August	September
Sales in units	4,000	4,200	4,800
Sales revenue	$400,000	$420,000	$480,000
Direct materials	74,000	77,700	88,800
Direct labour	88,600	93,030	106,320
Manufacturing overhead	63,480	65,160	70,680
Sales commission	30,000	31,500	36,000
Other selling expenses	41,960	43,620	44,360
Administrative expenses	31,550	31,550	31,550

Required:

6–1 What is the average price per unit sold?
6–2 Write the cost equation for direct materials.
6–3 Write the cost equation for direct labour.
6–4 Write the cost equation for manufacturing overhead.
6–5 Write the cost equation for sales commission.
6–6 Write the cost equation for other selling expenses.
6–7 Write the cost equation for administrative expenses.
6–8 Compute the total variable product costs per unit.
6–9 Compute the total variable selling and administrative costs per unit.
6–10 If 4,100 units are sold, what is the sales commission expense?
6–11 If 4,500 units are sold, what is the manufacturing overhead cost?
6–12 If 4,700 units are sold, what is the total cost?
6–13 What is the contribution margin per unit?
6–14 If 4,000 units are sold, what is the total contribution margin?
6–15 If 4,600 units are sold, what is the income?

Brief Exercises

BRIEF EXERCISE 6–1
Identifying Fixed and Variable Cost Behaviour [LO1 – CC1, 3]

Espresso Express operates a number of espresso coffee stands in busy suburban malls. The fixed weekly expense of a coffee stand is $2,200, and the variable cost per cup of coffee served is $0.18.

Required:

1. Complete the following table with your estimates of total costs and cost per cup of coffee at the indicated levels of activity for a coffee stand. Round the cost of a cup of coffee to the nearest tenth of a cent.

	Cups of Coffee Served in a Week		
	3,000	3,200	3,400
Fixed cost	?	?	?
Variable cost	?	?	?
Total cost	?	?	?
Cost per cup of coffee served	?	?	?

2. Does the cost per cup of coffee served increase, decrease, or remain the same as the number of cups of coffee served in a week increases? Explain.

BRIEF EXERCISE 6–2
Applying the High–Low Method [LO2 – CC9]

The Royal Canadian Lodge in Banff, Alberta, has accumulated records of the total electrical costs of the hotel and the number of occupancy-days over the last year. An occupancy-day represents a room rented out for one day. The hotel's business is highly seasonal, with peaks occurring during the ski season and in the summer.

Month	Occupancy-Days	Electrical Costs
January	1,736	$4,127
February	1,407	3,207
March	2,555	5,210
April	960	2,857
May	630	2,871
June	744	2,696
July	2,108	4,670
August	1,406	3,148
September	480	1,391
October	230	1,490
November	720	2,454
December	1,364	3,529

Required:

1. Using the high–low method, estimate the fixed cost of electricity per month and the variable cost of electricity per occupancy-day. Round the fixed cost to the nearest whole dollar and the variable cost to the nearest whole cent.
2. What factors other than occupancy-days are likely to affect the monthly variation in electrical costs?

BRIEF EXERCISE 6–3
Applying the Scattergraph Method [LO2 – CC10]

Oki Products, Ltd. has observed the following processing costs at various levels of activity over the past 10 months:

Month	Units Produced	Processing Cost
1	2,500	$28,000
2	11,000	52,000
3	15,000	59,000
4	5,500	38,000
5	9,000	47,000
6	8,500	52,000
7	7,500	44,000
8	7,000	41,000
9	11,500	52,000
10	6,000	41,000

Required:

1. Prepare a scattergraph by plotting these data on a graph. Plot cost on the vertical axis and units produced on the horizontal axis. Fit a line to your plotted points by visual inspection.
2. What is the approximate monthly fixed cost? The approximate variable cost per unit processed? Show your computations.

BRIEF EXERCISE 6–4
Applying the Least-Squares Regression Method [LO2 – CC11]

Required:

Using the data in Brief Exercise 6–3, repeat Requirement (2) using least-squares regression (using any spreadsheet software). Is units produced a reliable basis for estimating processing costs?

BRIEF EXERCISE 6–5
Understanding Cost Behaviour and Contribution Margin [LO1 – CC1, 3; LO3 – CC12]

Murugan Ltd. had the following results for the year:

Sales	$45,000
Less: Operating expenses	39,000
Net operating income	$ 6,000

The average selling price for the units sold was $15 per unit and average variable cost $9 per unit.

Required:

Prepare a contribution margin income statement.

BRIEF EXERCISE 6–6
Understanding Cost Behaviour: Mixed Costs [LO1 – CC6; LO2 – CC7, 8]

Which of the following are linear cost functions? Which are mixed cost functions? Given: Y = total costs, X_1 = production volume, and X_2 = number of batches produced.

1. $Y = 4{,}000 + 3X_1 + 45X_2$
2. $Y = 1{,}500 + 6X_1 + 4X_2$
3. $Y = 16{,}780$
4. $Y = 4.5X$
5. $Y = 12{,}450 + 3.20X^2$

BRIEF EXERCISE 6–7
Applying the High–Low Method [LO2 – CC9]

The utility costs for Pizza Parlour (PP) amounted to $12,520 and $16,040 in April and December respectively; during these months PP sold 24,000 and 32,000 pizzas (these were the lowest and highest recorded sales). Using the high–low method, develop a cost equation for utility costs.

BRIEF EXERCISE 6–8
Preparing a Contribution Margin Income Statement [LO3 – CC12]

The Alpine House, Inc. is a large retailer of winter sports equipment. Here is an income statement for the company's ski department for a recent quarter:

THE ALPINE HOUSE, INC. Income Statement—Ski Department For the Quarter Ended March 31		
Sales		$560,000
Less: Cost of goods sold		390,000
Gross margin		170,000
Less: Operating expenses:		
Selling expenses	$60,000	
Administrative expenses	20,000	80,000
Net income		$ 90,000

On average, skis sell for $800 per pair. Variable selling expenses are $50 per pair of skis sold. The remaining selling expenses are fixed. The administrative expenses are 17.5% variable and 82.5% fixed. The company does not manufacture its own skis; it purchases them from a supplier for $450 per pair.

Required:

1. Prepare a contribution margin income statement for the quarter.
2. For every pair of skis sold during the quarter, what was the contribution toward covering fixed expenses and toward earning profits?

Exercises

EXERCISE 6–1
Applying the High–Low Method; Predicting Cost [LO2 – CC9]

The Lakeshore Hotel's occupancy-days and custodial supplies expense over the last seven months were as follows:

Month	Occupancy-Days	Custodial Supplies Expense
March	18,000	$22,500
April	12,500	20,850
May	15,000	20,250
June	28,500	28,850
July	24,000	27,100
August	19,000	22,750
September	14,500	20,750

Occupancy-days are a measure of the overall activity at the hotel. For example, when a guest stays at the hotel for three days, it is counted as three occupancy-days.

Required:

1. Using the high–low method, estimate a cost formula for custodial supplies expense.
2. Using the cost formula you derived above, what amount of custodial supplies expense would you expect to be incurred at an occupancy level of 13,000 occupancy-days?

EXERCISE 6–2
Applying the Least-Squares Regression Method [LO2 – CC11]

Required:

Repeat Requirements (1) and (2) of Exercise 6–1 using least-squares regression (you may use a spreadsheet to compute the fixed and variable costs). Comment on the reliability of using occupancy-days as an allocation base.

EXERCISE 6–3
Applying the High–Low and Scattergraph Methods [LO2 – CC8, 9, 10]

Refer to the data in Exercise 6–1.

Required:

1. Prepare a scattergraph by plotting custodial supplies expense on the vertical axis and occupancy-days on the horizontal axis. Fit a regression line to your plotted points by visual inspection.
2. What is the approximate monthly fixed cost? The approximate variable cost per occupancy-day?
3. Scrutinize the points on your graph, and explain why the high–low method would or would not yield an accurate cost formula in this situation.

EXERCISE 6–4
Applying the High–Low and Scattergraph Methods [LO2 – CC9, 10]

The following data relating to units shipped and total shipping expense have been assembled by Archer Company, a manufacturer of large, custom-built air-conditioning units for commercial buildings:

Month	Units Shipped	Total Shipping Expense
January	3	$1,800
February	6	2,300
March	4	1,700
April	5	2,000
May	7	2,300
June	8	2,700
July	2	1,200

Required:

1. Estimate a cost formula for shipping expense using the high–low method.
2. For the scattergraph method, do the following:
   a. Prepare a scattergraph using the data given above. Plot total shipping expense on the vertical axis and units shipped on the horizontal axis. Fit a regression line to your plotted points by visual inspection.
   b. Using your scattergraph, estimate the approximate variable cost per unit shipped and the approximate fixed cost per month.
3. What factors, other than the number of units shipped, are likely to affect the company's total shipping expense? Explain your reasoning.

EXERCISE 6–5
Applying the High–Low Method; Predicting Cost [LO2 – CC7, 9]

Hoi Chong Transport, Ltd. operates a fleet of delivery trucks in Singapore. The company has determined that if a truck is driven 114,800 kilometres during a year, the average operating cost is 12.5 cents per kilometre. If a truck is driven only 70,000 kilometres during a year, the average operating cost increases to 14.5 cents per kilometre. (The Singapore dollar is the currency used in Singapore.)

Note: In your computations, please do not round the decimal places of cost per kilometre.

Required:

1. Using the high–low method, estimate the variable and fixed cost elements of the annual cost of truck operation.
2. Express the variable and fixed costs in the form $Y = a + bX$.
3. If a truck were driven 80,000 kilometres during a year, what total cost would you expect to be incurred?

EXERCISE 6–6
Examining Cost Behaviour and Contribution Margin [LO1 – CC1, 3; LO2 – CC7; LO3 – CC12]

Bikes Manufacturing produces and sells children's bikes at an average price of $60. Its costs are as follows: direct materials, $12; direct labour, $7; variable overhead, $3; sales commission, 5% of price. Its fixed monthly costs are $38,000.

Required:

1. Using the above cost data, set up a monthly cost equation.
2. What is the company's contribution margin percentage?

EXERCISE 6–7
Understanding Cost Behaviour and Contribution Margin Income Statement [LO1 – CC1, 3; LO3 – CC12]

Harris Company manufactures and sells a single product. A partially completed schedule of the company's total and per-unit costs over the relevant range of 30,000 to 50,000 units produced and sold annually is given below:

	Units Produced and Sold		
	30,000	40,000	50,000
Total costs:			
Variable costs	?	?	$300,000
Fixed costs	?	?	?
Total costs	?	?	?
Cost per unit:			
Variable cost	?	?	?
Fixed cost	10.00	?	?
Total cost per unit	?	?	?

Required:

1. Complete the schedule of the company's total and unit costs.
2. Assume that the company produces and sells 38,000 units during a year at a selling price of $16 per unit. Prepare a contribution margin income statement for the year.

Problems

PROBLEM 6–1
Applying the High–Low Method; Predicting Cost [LO2 – CC9]

HECK FIGURE
$294,637 per month plus $4.75 per bed-day

St. Mark's Hospital contains 450 beds. The occupancy rate varies between 50% and 90% per month, but the average occupancy rate is generally 80%. In other words, on average, 80% of the hospital's beds are occupied by patients. At this level of occupancy, the hospital's operating costs are $32 per occupied bed per day, assuming a 30-day month. This $32 figure contains both variable and fixed cost elements. This average cost figure drops to $29 when the occupancy rate is 90% (typically during the months of July and August).

During June, the hospital's occupancy rate was only 50% and a total of $326,700 in operating costs was incurred during the month.

Required:

1. Using the high–low method, estimate
   a. The variable cost per occupied bed on a daily basis.
   b. The total fixed operating costs per month.
2. Assume an occupancy rate of 70% per month. What amount of total operating cost would you expect the hospital to incur?

PROBLEM 6–2
Applying the Scattergraph Method [LO2 – CC10]

CHECK FIGURE
(2) Approximately $11,750 per month plus $0.585 per kilometre driven

Molina Company is a value-added computer reseller that specializes in providing services to small companies. The company owns and maintains several vehicles for use by its sales staff. All expenses of operating these vehicles have been entered into an automobile expense account on the company's books. Along with this record of expenses, the company has also kept a careful record of the number of kilometres the vehicles have been driven each month.

The company's records of kilometres driven and total vehicle expenses over the past 10 months are given below:

Month	Kilometres Driven (000)	Total Cost
January	4	$13,000
February	8	15,700
March	7	15,300
April	12	17,000
May	6	14,300
June	11	16,500
July	14	18,000
August	10	15,000
September	13	18,100
October	15	18,400

Molina Company's president wants to know the cost of operating the fleet of vehicles in terms of the fixed monthly cost and the variable cost per kilometre driven.

Required:

1. Prepare a scattergraph using the data provided. Place cost on the vertical axis and activity (kilometres driven) on the horizontal axis. Fit a regression line to the plotted points by simple visual inspection.
2. By analyzing your scattergraph, estimate fixed cost per month and the variable cost per kilometre driven.

PROBLEM 6–3
Applying the High–Low, Scattergraph, and Least-Squares Regression Methods [LO2 – CC8, 9, 10]

CHECK FIGURE
(1) $2,113 per month plus $53.41 per scan

Mountain View Hospital in Alberta has just hired a new chief administrator, who is anxious to employ sound management and planning techniques in the business affairs of the hospital. Accordingly, she has directed her assistant to summarize the cost structure existing in the various departments to secure data for planning purposes.

The assistant is unsure how to classify the utilities costs in the radiology department, since these costs do not exhibit either strictly variable or strictly fixed cost behaviour. Utilities costs are very high in the department due to a CT scanner that draws a large amount of power and is kept running at all times. The scanner cannot be turned off due to the long warm-up period required for its use. When the scanner is used to scan a

patient, it consumes an additional burst of power. The assistant has accumulated the following data on utilities costs and use of the scanner since the first of the year:

Month	Number of Scans	Utilities Cost
January	40	$ 4,250
February	85	6,300
March	100	7,000
April	150	10,400
May	200	14,000
June	110	8,500
July	260	16,000
August	160	11,700
September	210	15,100
October	180	13,500

The chief administrator has informed her assistant that the utilities cost is probably a mixed cost that will have to be broken down into its variable and fixed cost elements by use of a scattergraph. The assistant feels, however, that if an analysis of this type is necessary, the high–low method should be used because it is easier and quicker to use than other methods. The controller has suggested that there might be a better approach.

Required:

1. Using the high–low method, estimate a cost formula for utilities. Express the formula in the form $Y = a + bX$. (The variable rate should be stated in terms of cost per scan.)
2. Prepare a scattergraph by plotting the above data on a graph. (The number of scans should be placed on the horizontal axis, and utilities cost should be placed on the vertical axis.) Fit a regression line to the plotted points by visual inspection, and estimate a cost formula for utilities.
3. Estimate a cost formula using least-squares regression (use a spreadsheet).
4. Comment on the differences among the three cost formulas estimated above. Which one would you use?

PROBLEM 6–4
Examining Cost Behaviour; High–Low Analysis; Contribution Margin Income Statement
[LO1 – CC1, 3, 6; LO2 – CC9; LO3 – CC12]

HECK FIGURE
Shipping: A$18,000 per month plus A$4 per unit

Morrisey & Brown, Ltd., of Sydney, Australia, is a merchandising firm that is the sole distributor of a product that is increasing in popularity among Australian consumers. The company's income statements for the three most recent months follow:

MORRISEY & BROWN, LTD.
Income Statements
For the Four Quarters Ending December 31

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Sales in units	4,400	4,000	5,000	4,600
Sales revenue	A$440,000	A$400,000	A$500,000	A$460,000
Less: Cost of goods sold	264,000	240,000	300,000	276,000
Gross margin	176,000	160,000	200,000	184,000
Less: Operating expenses:				
Advertising expense	21,000	21,000	21,000	21,000
Shipping expense	35,000	34,000	38,000	36,000
Salaries and commissions	83,000	78,000	90,000	85,000
Insurance expense	6,000	6,000	6,000	6,000
Depreciation expense	15,000	15,000	15,000	15,000
Total operating expenses	160,000	154,000	170,000	163,000
Net income	A$ 16,000	A$ 6,000	A$ 30,000	A$ 21,000

(*Note:* Morrisey & Brown, Ltd.'s Australian-formatted income statement has been recast into the format common in Canada. The Australian dollar is denoted by A$.)

Required:

1. Identify each of the company's expenses (including cost of goods sold) as being variable, fixed, or mixed.
2. Using the high–low method, separate each mixed expense into variable and fixed elements. State the cost formula for each mixed expense.
3. Redo the company's income statement at the 5,000-unit level of activity using the contribution format.
4. Assume that the company's sales are projected to be 4,500 units in the next quarter. Prepare a contribution margin income statement.

PROBLEM 6–5
Applying the High–Low Method and Cost Behaviour [LO2 – CC9]

CHECK FIGURE
(2) ¥1,300,000 per year plus ¥14.50 per DLH

Sawaya Co., Ltd., of Japan, is a manufacturing company whose total factory overhead costs fluctuate considerably from year to year according to increases and decreases in the number of direct labour-hours worked in the factory. Total factory overhead costs (in Japanese yen, denoted ¥) at high and low levels of activity for recent years are provided below:

	Level of Activity	
	Low	High
Direct labour-hours	100,000	150,000
Total factory overhead costs	¥12,450,000	¥15,275,000

The factory overhead costs above consist of indirect materials, rent, and maintenance. The company has analyzed these costs at the 100,000-hour level of activity as follows:

Indirect materials (V)	¥ 4,200,000
Rent (F)	5,500,000
Maintenance (M)	2,750,000
Total factory overhead costs	¥12,450,000

V = variable; F = fixed; M = mixed.

To have data available for planning, the company wants to break the maintenance cost down into its variable and fixed cost elements.

Required:

1. Estimate how much of the ¥15,275,000 factory overhead cost at the high level of activity consists of maintenance cost. (*Hint:* To do this, it may be helpful to first determine how much of the ¥15,275,000 consists of indirect materials and rent. Think about the behaviour of variable and fixed costs!)
2. By means of the high–low method of cost analysis, estimate a cost formula for maintenance.
3. What total factory overhead costs would you expect the company to incur at an operating level of 70,000 direct labour-hours?

PROBLEM 6–6
Applying the High–Low Method and Predicting Cost [LO2 – CC9]

CHECK FIGURE
(2) $9,000 per month plus $1.60 per machine-hour

Nova Company's total overhead costs at various levels of activity follow:

Month	Machine-Hours	Total Overhead Costs
April	70,000	$198,000
May	100,000	270,000
June	80,000	222,000
July	90,000	246,000

Assume that the total overhead costs consist of utilities, supervisory salaries, and maintenance. The breakdown of these costs at the 70,000 machine-hour level of activity is as follows:

Utilities (V)	$ 56,000
Supervisory salaries (F)	21,000
Maintenance (M)	121,000
Total overhead costs	$198,000

V = variable; F = fixed; M = mixed.

Nova Company's management wants to break the maintenance cost down into its basic variable and fixed cost elements.

Required:

1. As shown, overhead costs in May amounted to $270,000. Determine how much of this consisted of maintenance cost. (*Hint:* To do this, it may be helpful to first determine how much of the $270,000 consisted of utilities and supervisory salaries. Think about the behaviour of variable and fixed costs!)
2. By means of the high–low method, estimate a cost formula for maintenance.
3. Express the company's *total* overhead costs in the linear equation form $Y = a + bX$.
4. What *total* overhead costs would you expect to be incurred at an operating activity level of 75,000 machine-hours? At an operating activity level of 105,000 machine-hours?

PROBLEM 6–7

Applying the High–Low Method; Cost of Goods Manufactured [LO2 – CC9; CHAPTER 2 LO6 – CC12]

ECK FIGURE
$166,000 per month plus $3 per unit

Amfac Company manufactures a single product. The company keeps careful records of manufacturing activities, from which the following information has been extracted:

	Level of Activity	
	March	June
Number of units produced	5,000	9,000
Cost of goods manufactured	$268,000	$397,000
Work-in-process inventory, beginning	29,000	21,000
Work-in-process inventory, ending	52,000	15,000
Direct materials cost per unit	10	10
Direct labour cost per unit	12	12
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 month.

Required:

1. For both March and June, determine the amount of manufacturing overhead cost added to production. (*Hint:* A useful way to proceed might be to construct a schedule of cost of goods manufactured.)
2. By means of the high–low method of cost analysis, estimate a cost formula for manufacturing overhead. Express the variable portion of the formula in terms of a variable rate per unit of product.
3. Assume that Amfac produced 8,000 units in September. What will be the cost of goods manufactured? (Assume that beginning and ending work-in-process inventories were $18,000 and $10,000 respectively.)

PROBLEM 6–8
Applying the High–Low Method; Least-Squares Regression [LO1 – CC5; LO2 – CC9, 11]

CHECK FIGURE
(2) $125,664 + $1,112 per customer

Dylan Flaherty, marketing clerk for TipTop Marketing Agency, recorded the following information for last year:

Month	Number of Customers	Customer Service Costs
January	341	$524,908
February	402	542,010
March	318	479,280
April	496	698,340
May	385	528,250
June	442	654,660
July	351	541,970
August	480	678,900
September	330	468,540
October	498	679,440
November	428	626,780
December	400	540,500

He would like to be able to estimate customer service costs using the number of customers as the basis for estimation. However, because he has never taken a course in managerial accounting, he does not know how to set up a cost equation. He has therefore approached you for help.

Required:

1. Set up a cost equation for monthly customer service costs using the high–low method.
2. Using the equation from Requirement (1), compute the estimated customer service costs if the number of customers is expected to be 550.
3. You also used the least-squares regression method to do the analysis of the costs; the analysis resulted in the following output:

Intercept:	82,231.04
Coefficient of *X*-variable:	1,227.02
Adjusted *R* square:	0.91

- Set up a cost equation using the above numbers.
- Explain the significance of *R* square.

PROBLEM 6–9
Preparing a Contribution Margin Income Statement [LO3 – CC12]

CHECK FIGURE
(2) Contribution margin, $4,793,600

Gallop Corporation prepared the following report for the first quarter of this year:

Sales (@ $2,800 per unit)		$7,840,000
Less: Cost of goods sold		4,139,520
Gross margin		3,700,480
Less:		
Selling expenses	$1,254,400	
Administrative expenses	1,000,000	2,254,400
Income		$1,446,080

Gallop's controller, Nancy Johnstone, studied the costs in detail, particularly focusing on cost behaviour. Her analysis revealed the following:

- Fixed portion of the cost of goods sold for the quarter amounted to $1,344,000.
- Of the selling expenses, 20% was variable with respect to the number of units.
- All of the administrative expenses were fixed.

Required:

1. Express the cost of goods sold and the selling expenses in terms of cost equations.
2. Redo the above income statement using a contribution margin approach.

PROBLEM 6–10

Cost Behaviour, Analysis of Mixed Costs, Contribution Margin Income Statement

[LO1 – CC1, 3, 6; LO2 – CC7, 9; LO3 – CC12]

HECK FIGURE
Contribution margin, $269,500

The Central Valley Company is a manufacturing firm that produces and sells a single product. The company's revenues and expenses for the last four months are given below.

Central Valley Company
Comparative Monthly Income Statements

	March	April	May	June
Sales in units	5,000	4,500	5,250	6,000
Sales revenue	$700,000	$630,000	$735,000	$840,000
Less: Cost of goods sold	370,000	342,000	379,000	426,000
Gross margin	330,000	288,000	356,000	414,000
Less: Operating expenses				
Shipping expense	61,500	56,000	65,000	71,000
Advertising expense	70,000	70,000	70,000	70,000
Salaries & commissions	160,800	143,000	161,500	180,500
Insurance expense	9,000	9,000	9,000	9,000
Depreciation expense	42,000	42,000	42,000	42,000
Total operating expenses	343,000	320,000	347,500	372,500
Net income	$(13,300)	$(32,000)	$ 8,500	$ 41,500

Required:

1. Management is concerned about the losses experienced during the spring and would like to know more about the cost behaviour. Develop a cost equation for each of the costs.
2. Using the cost equations, prepare a contribution margin income statement (in good form) for September when 5,500 units are expected to be sold.

Building Your Skills

COMPREHENSIVE PROBLEM [LO1 – CC5; LO2 – CC9, 10]

Coral, Inc. manufactures a variety of products. The following data pertains to its plant in Chennai, India, which is relatively new and manufactures auto parts. Management wants to better understand the behaviour of overhead costs in order to better estimate and manage these costs. Management believes that direct

labour-hours are a good driver of overhead costs; moreover labour-hours data is readily available. Historical data for the past two years is available and is as follows:

CHECK FIGURE
(1) Cost formula, $Y = \$455{,}590 + \$5.40X$ (using data for the two-year period)

	Year 1		Year 2	
	Direct Labour-Hours	Overhead Cost	Direct Labour-Hours	Overhead Cost
January	70,000	$840,000	73,500	$860,450
February	84,000	990,450	87,500	928,450
March	77,000	855,000	80,500	940,400
April	80,500	902,250	77,000	870,000
May	70,000	815,000	70,000	800,000
June	66,500	735,850	63,000	775,000
July	49,000	745,000	42,000	675,000
August	35,000	645,000	45,500	700,900
September	42,000	690,000	52,500	735,000
October	59,500	750,000	59,500	725,850
November	56,000	695,000	52,500	710,000
December	66,500	780,000	63,000	718,000

All equipment in the Chennai plant is leased under an arrangement calling for a flat fee up to 70,000 direct labour-hours of activity in the plant, after which lease charges are assessed on an hourly basis. Lease expense is a major item of overhead cost.

Required:

Complete Requirements (1) and (2) using data for each year as well as the full two-year period.

1. Using the high–low method, estimate the cost formula for overhead in the Chennai plant.
2. Using the least-squares regression method, estimate the cost formula for overhead in the Chennai plant.
3. Assume that the Chennai plant works 78,750 and 54,500 direct labour-hours respectively during two different months. Compute the expected overhead cost for the month using the cost formulas developed for the two-year period with
   a. The high–low method.
   b. The regression method.
4. Of the two proposed methods, which one should Coral, Inc. use to estimate monthly overhead costs in the Chennai plant? Explain fully, indicating the reasons why the other method is less desirable.
5. How is the concept of relevant range applicable to the Chennai plant?

THINKING ANALYTICALLY [LO2 – CC9, 11]

Kilpauk Corporation, located in London, Ontario, has gathered data on its overhead activities and associated costs for the past 12 months. Nancy Cruder, a member of the controller's department, has convinced management that manufacturing overhead costs can be better estimated and controlled if the fixed and variable components of each overhead activity are known. Nancy has identified three possible variables (activity bases) that influence costs: (1) maintenance-hours, (2) machine-hours and (3) kilowatt-hours of power consumption. She does not know which activity base will be a better predictor of costs. Therefore, she decides to gather data over a one-year period (see below).

CHECK FIGURE
(1) Monthly cost equation: $3,000 per month + $13.333 per maintenance-hour

Month	Maintenance-hours	Machine-hours	Kilowatt-hours	Overhead Cost
1	1,150	30,000	1,640	$15,980
2	900	25,000	1,620	15,000
3	1,480	45,000	2,380	24,200
4	1,320	32,000	1,600	17,000
5	1,300	44,000	2,300	22,150
6	1,500	28,000	1,900	18,000
7	1,450	55,000	2,550	25,500
8	1,400	39,000	2,150	23,660
9	1,650	23,500	2,600	25,000
10	1,150	23,000	1,620	15,240
11	1,250	37,500	2,160	21,900
12	1,000	35,000	1,860	19,400

Required:

1. Using the high–low method, develop three cost formulas for the manufacturing overhead costs using the three alternative independent variables (activity bases).
2. Using the least-squares regression method, develop three cost formulas for the manufacturing overhead costs using the three alternative independent variables (activity bases). You may use Excel or another spreadsheet to compute the answer.
3. The company expects the following activity during each of the next two months: (1) maintenance-hours, 1,200 and 1,500; (2) machine-hours, 40,000 and 50,000; and (3) kilowatt-hours, 2,000 and 2,500. Compute the estimated costs for each of the two months using all the cost formulas that you have developed in Requirements (1) and (2).
4. Comment on the differences in costs that you have estimated in Requirement (3), above. Which of the two methods (high–low versus regression) would you prefer in developing a cost formula? Why? Which of the three activity bases would you prefer to use? Why?

COMMUNICATING IN PRACTICE [LO1 – CC1, 2, 3, 5, 6]

Maria Chavez owns a catering company that serves food and beverages at parties and business functions. Chavez's business is seasonal, with a heavy schedule during the summer months and holidays and a lighter schedule at other times.

One of the major events requested by Chavez's customers is a cocktail party. She offers a standard cocktail party and has estimated the total cost per guest as follows:

Food and beverages	$15.00
Labour (0.5 hours @ $10 per hour)	5.00
Overhead (0.5 hours @ $13.98 per hour)	6.99
Total cost per guest	$26.99

The standard cocktail party lasts three hours, and she hires one worker for every six guests, which works out to one-half hour of direct labour per guest. The servers work only as needed and are paid only for the hours they actually work.

When bidding on cocktail parties, Chavez adds a 15% markup to yield a price of $31 per guest. Chavez is confident about her estimates of the costs of food, beverages, and labour, but is not as comfortable with the estimate of overhead cost. The overhead cost per guest was determined by dividing total overhead expenses for the last 12 months by total labour-hours for the same period. Her overhead includes such costs as annual rent for office space, administrative costs (including those relating to hiring and paying workers), and so on.

Chavez has received a request to bid on a large fundraising cocktail party to be given next month by an important local charity. (The party would last three hours.) She would really like to win this contract—the guest list for this charity event includes many prominent individuals she would like as future clients.

Other caterers have also been invited to bid on the event, and she believes that one, if not more, of those companies will bid less than $31 per guest. She is not willing to lose money on the event and needs your input before making any decisions.

Required:

Write a memorandum to Ms. Chavez that addresses the validity of her concern about her estimate of overhead costs and whether she should base her bid on the estimated cost of $26.99 per guest. (*Hint:* Start by discussing the need to consider cost behaviour when estimating costs. You can safely assume that she will not incur any additional fixed costs if she wins the bid on this cocktail party.)

ETHICS CHALLENGE [LO1 – CC1, 3; LO2 – CC9, 10, 11; LO3 – CC12]

"I truly think that we should use the scattergraph method to analyze mixed costs," said Suzanne Arthur to her accountant, Jane Golding. "It gives us the flexibility to manage the proportion of variable and fixed costs according to the decisions that we are required to make."

Jane wondered whether this would offer flexibility or the ability to manipulate the data as individual managers saw fit. "How can this so-called flexibility be good, when I can compute 10 different amounts for contribution margin and claim that they are all correct?" she asked herself. She turned to her handbook of the International Financial Reporting Standards (IFRS), but found no reference to this in the standards.

Required:

1. Do you believe that the scattergraph method gives managers the ability to manipulate costs?
2. Do you believe that the use of a particular method can lead to an ethical dilemma? Why or why not?

TEAMWORK IN ACTION [LO1 – CC1, 3, 5]

Assume that your team is going to form a company that will manufacture chocolate chip cookies. The team is responsible for preparing a list of all product components and costs necessary to manufacture this product.

Required:

1. The team should discuss and then write a brief description of the definitions of variable, fixed, and mixed costs. All team members should agree with and understand the definitions.
2. After preparing a list of all product components and costs necessary to manufacture your cookies, identify each of the product costs as direct materials, direct labour, or factory overhead. Then identify each of those costs as variable, fixed, or mixed.
3. Prepare to report this information in class. (Each teammate can assume responsibility for a different part of the presentation.)