

Intermediate Management Accounting

Week 1

Student Notes

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WEEK 1 — STUDENT NOTES

OVERVIEW

This week will lay the groundwork for the course by introducing management accounting, the role of the management accountant and the terminology of management accounting. It is important to know the definitions of the terms as they will be used throughout the course, and some will be used in other CPA preparatory courses. The material for this week also discusses cost behaviours, and how management accountants determine these behaviours and then use them to predict costs and profits using cost-volume-profit analysis. This week also focuses on how information systems have changed the way management decisions are made. Power BI will be used to demonstrate how big data can be summarized in a visualization and used for what-if analysis.

TOPIC 1.1: ROLE OF THE MANAGEMENT ACCOUNTANT

Learning objectives:

- Outline the three components of the role of management accountants.
- Compare and contrast management accounting with financial accounting.
- Describe the three primary functions of management accountants.
- Explain the need for information quality.
- Describe the information format best suited to the decision type and management level.
- Describe the ethics involved in data management and protection.

The role of management accounting is to support decision-making within organizations. This role has three components:

- recording and evaluating costs
- developing information to support planning and control systems
- developing, implementing, and operating performance measurement and evaluation systems

1.1-1 Management accounting versus financial accounting

Management accounting serves the needs of decision makers inside organizations, whereas financial accounting serves a fiduciary role by reporting to shareholders and other interested parties outside the organization. Although both management and

financial accounting rely on financial information, they have different perspectives, as illustrated in the table that follows:

Management accounting	Financial accounting
<ul style="list-style-type: none"> • focused on internal decision makers • driven by decision-making requirements within the organization • generally forward looking (future oriented) • includes both financial and non-financial information 	<ul style="list-style-type: none"> • focused on external stakeholders • driven by generally accepted accounting principles • generally backward looking (historically oriented) • includes only financial information

1.1-2 The evolving roles of management accounting and the management accountant

Management accounting has a long history of providing information needed to operate businesses (especially information on product costs and budgets). However, because of a focus on formalizing financial reporting to safeguard the interests of shareholders, management accounting did not evolve much until late in the 20th century.

Given the different perspectives and priorities of management and financial accounting, the focus on meeting external reporting standards after the 1929 stock market failure led to a decline in the relevance of management accounting in supporting internal decision-making. This decline reversed in the 1980s as increasing global competition required organizations to recognize the importance of employing management accounting practices driven by the strategic needs of internal decision makers.

Since the 1980s, management accounting practice has made huge improvements in three areas: cost measurement, the alignment of performance measurement with strategy, and performance evaluation. The progress of management accounting has been driven by the needs and expectations of decision makers. In the past, decisions were made to benefit only the decision maker's organization. As more organizations collaborate as supply-chain partners, strategic decisions are being made that benefit multiple organizations in achieving their goals. Management accounting is only relevant when it supports those organizational goals and operational needs.

Herb Simon, an economist whose writings contributed to the field of management accounting, identified three primary roles of the management accountant:

- scorekeeping
- attention directing
- problem solving

Scorekeeping refers to the task of recording relevant accounting information. Recording the cost of production is an example of scorekeeping.

Attention directing refers to organizing recorded data into a format useful in supporting decision-making. Producing a report that identifies results and indicates where results differed from the plan is an example of attention directing.

Problem solving refers to identifying possible causes of measured results and offering suggestions for improvement. Identifying the reason why production costs exceeded planned costs and proposing a solution to avoid this in the future is an example of problem solving. Problem solving can also exist with trading partners. Consider a supply chain where a direct materials supplier works with the manufacturer to ship materials based on daily customer demand. This assists both trading partners in planning and reducing storage costs and in providing faster turnaround of service to the end customer.

The job cost sheet, possibly the oldest known management accounting tool, can be used to illustrate these management accountant roles. It summarizes either the prospective costs of a job (when a bid is being prepared) or the actual costs of the job when the price charged will be a function of the cost. By providing this summary, the job cost sheet helps fulfil the scorekeeping role of the management accountant. As part of the attention-directing role, a job cost sheet could compare the expected costs of a job with the actual job costs and highlight cost differences (which management accountants call variances). Finally, the management accountant might identify the suspected cause of a variance and a recommended action, which illustrates the problem-solving role.

When the historical records of all job cost sheets are combined, the management accountant can review trends in costs of jobs over time. These trends, in conjunction with market trends relating to employment and weather patterns that may have affected the growth and harvest of direct ingredients or the demand for product, can be used to adjust future operations or cost expectations. Consider trends in summer weather patterns and the production of air conditioners. With the use of expertise stored in knowledge bases by meteorologists, management accountants can make more informed decisions relating to the demand for air conditioners. The availability of this diverse data has positioned the management accountant in a key strategic role in corporate decision-making.

1.1-3 Management accounting and cost accounting

Practitioners still use the terms *cost accounting* and *management accounting* when referring to management accounting practice. Cost accounting refers to approaches and methods for developing cost information, such as the cost of a product or unit of service. Management accounting has a broader connotation, which includes cost accounting, and planning and control practices that management accountants have developed. Examples of planning and control tools include budgets, operations reports, and performance measurement systems.

1.1-4 Role of management accounting in management of the organization

There are three important areas where the management accountant can play an important role in the overall management of organizations: goal alignment; the planning and control cycle; and budgets and variances.

Aligning individual and organizational goals

An organization can only make significant progress toward achieving its goals and objectives when the goals and objectives of its management and employees are aligned with those of the organization. Management accountants can play an important role in aligning these goals through the use of properly designed performance measurement and reward systems.

The planning and control cycle

Planning is the process of identifying the organization's objectives and then developing and implementing a strategy to achieve those objectives. Control is the process of measuring the results of actions associated with the chosen strategy and developing and implementing any action intended to help the organization achieve its objectives. Management accountants add value by developing and implementing strategy and especially by measuring the results from implementing and evaluating alternative courses of action. (This area is a consistent theme throughout all the weeks in this course.)

Budgets and variances

Historically, budgets are the most important tools management accountants have used to effect organizational control. Budgets lay out the expected financial consequences of business decisions. Management accountants compare the actual results for the planning period with the budget amounts and focus on the differences (variances) between budget amounts and actual amounts. Variances, therefore, are a form of exception reporting rooted in the accountability perspective that focuses on deviations from budgeted results. (Budgets will be explored in Week 4, and variances will be covered in Week 5.)

1.1-5 Role of information in management accounting decision-making

Information quality

To serve the needs of decision makers in the organization, the management accountant must have access to quality information. The three basic characteristics of quality information are relevance, timeliness, and accuracy.

Relevant information consists of data that is applicable to the situation. Often, in management accounting, it is related to those costs or revenues that will differ between alternative decisions. However, with the availability of more non-financial data, the management accountant also has access to qualitative information to assist in decision-

making. Both internal and external sources are used to compile this relevant information. Consider the use of social media to learn more about consumer lifestyles for new product development.

Information should be timely in that it must be available in time to make an effective decision. In highly competitive environments, this means the information must be in a format that can be quickly located and summarized for decision-making. For example, wineries will want to know the latest news on medical research relating to the health issues surrounding alcohol consumption.

The definition of accurate information can vary, depending on the source and use of the information. When recording the receipt of cash, accuracy is key, as the dollar amount must be accurate to ensure the proper control of cash, so the book balance aligns with the bank balance. However, when forecasting sales based on future weather patterns, expected temperature changes in the next year are predicted with a degree of uncertainty.

Information format

Information must be formatted based on the user's needs. A plant floor supervisor will schedule workers based on the number of production hours required to satisfy next week's demand. However, the vice-president of production will be more interested in a summary of the trend of production hours over the last five years.

The following table summarizes the information format required and its source, based on the level of decision maker in the organization, the type of decision made, and the time frame affected by the decision.

Level of management	Decision type	Time frame affected (approximate)	Information format and source
Employees and supervisors	Operational/routine decisions	Short term – one day to one month	Structured Sourced internally via: <ul style="list-style-type: none"> • transaction processing systems (accounting based) • Excel spreadsheets
Middle management	Tactical decisions — what-if analysis	One month to one year	Semi-structured Sourced mostly internally via: <ul style="list-style-type: none"> • reports from management information systems • Excel data analysis tools and dashboards

Senior management	Strategic decisions — one-off decisions	Long term – one year to future years	Non-structured/ad hoc: Sourced internally and externally via business intelligence systems: <ul style="list-style-type: none"> • decision support systems • data mining • expert systems
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Throughout this course, the topic of information in management decision-making will be discussed based on the type of decision made, the level of management making the decision, the format of the data, and the appropriate model and tool to assist the decision maker. Much of the terminology here will be further explained over the next six weeks.

Information availability

The challenge facing the management accountant is less in finding data than in determining which data is relevant to making the best decision. Data is available from numerous sources and in multiple formats. The term “big data” is used to describe this growing volume of data which is available not only from company records, but also from external resources that have become more accessible through a variety of applications including the World Wide Web. Some data, such as a set of inventory records, are structured, with fields describing the quantity and cost of each inventory item on hand. Other data, such as pictures, emails, tweets, and video, are less structured. Both have the potential of being valuable in the decision-making process.

There is a growing need for management accountants to work with information systems professionals to look for patterns and associations between both structured and unstructured data. This activity, called data mining, can result in information that can be turned into business intelligence used to make strategic business decisions.

The management accountant, data, and ethics

While managers at every level in the organization must be responsible in their use of data, management accountants have an even greater role in ensuring the data used for decision-making accurately represents the decision being made. Rule 205 of the CPA British Columbia Code of Professional Conduct states the following:

‘...a registrant shall not make or associate with any oral report, statement or representation which the registrant knows or should know, is false or misleading.’¹

Where the decision calls for randomized selection, data that is “hand picked” is not reliable and thus not a faithful representation of the details contained in the data set.

¹ CPABC, CPABC Code of Professional Conduct (2018), p. 111, <https://www.bccpa.ca/CpaBc/media/CPABC/Members/Regulatory/Governing%20Documents/CPABC-Code-of-Professional-Conduct.pdf>

Decisions based on this data may lead to outcomes that are not in the best interests of the company. Consider the future effect on quality if a quality report was designed to show only those batches of product that were manufactured without the need for rework.

The European Union's new General Data Protection Regulation is an example of a new level of regulations around an individual's right to have their private data protected. This specific regulation affects any company that does business with a resident of the European Union and as such would potentially affect all online retailers. Other countries, states, and provinces are working on similar legislation. Protecting the right to privacy has become the responsibility of all employees in a business. Thus, management accountants are also responsible for the protection of the right to privacy when it comes to an individual's private information. The *Personal Information Protection and Electronic Documents Act* (PIPEDA) governs this right. It consists of:

- the individual's right to know what private information the organization is retaining and how that information will be used
- the responsibility of the organization to keep the individual's private information secure

These guidelines must be followed when making decisions that may affect individual rights. For example, the data from global positioning systems in employer-provided vehicles to track employee productivity can provide useful costing and scheduling decisions. However, collecting that data without the employee's knowledge is not only unethical; it also violates the provisions in the PIPEDA.

TOPIC 1.2: COST CLASSIFICATIONS

Learning objectives:

- Describe the cost distinctions important to financial accounting.
- Define cost object, cost pool, direct cost, indirect cost, assigned cost, and allocated cost.
- Explain the costing system architecture.
- Define the cost terms used to describe cost behaviour.
- Describe the cost distinction important to manufacturing systems, to planning and control, and to decision-making.

Like all professions, management accounting has important and specialized terms; these make communication about costs among management accountants more efficient and precise. For management accountants, the term *cost* is ambiguous. Management accountants have a saying: "Different costs for different purposes." This reflects the perspective that management accounting serves decision-making needs, which often call for different types of cost calculations.

For management accountants, many of the cost terms introduced here have special meanings that differ from common use. Therefore, clearly understanding how management accountants use these cost terms provides an important foundation for the lessons that follow.

1.2-1 Cost distinctions important to financial accounting

Financial accountants find the following two cost definitions important.

Product costs (or inventoriable costs)

Both management accountants and financial accountants call an estimate of a product's costs a *product cost*. However, there are important differences.

For financial accountants, product cost includes only the cost of manufacturing or acquiring a product. Management accountants may sometimes start with the financial accountants' definition of product cost and then add the cost of promoting, distributing, and servicing the product in the customer's hands, if these costs can be reasonably traced to the product; this results in a more comprehensive total product cost. This type of costing may be used to make decisions about improving a product's profitability or even dropping the product from the company's offerings. In other words, the management accountant, not bound by the rules of external reporting, may develop cost information that is relevant to the decision being made.

Period costs

Period costs are costs that accountants (financial or management) do not count as product costs. Financial accountants treat all non-manufacturing costs, such as selling, administrative, and research and development costs, as period costs. Therefore, inventory costs consist only of manufacturing costs.

Management accountants have some flexibility when classifying costs, and where possible, they attempt to allocate costs using the cost drivers and tracing costs to the cost object in a way that will assist in assessing those costs when making decisions. For example, a management accountant might treat advertising designed to promote a company's name as a period cost but treat advertising designed to promote a specific product as a product cost.

1.2-2 Costing terms critical in costing system design

Cost object

A *cost object* is anything to which a cost can be traced. Cost objects include products (goods or services), product lines, departments, divisions, and even entire organizations.

Cost pool

A *cost pool* is an account that accumulates costs.

Direct cost

A *direct cost* is any cost that can be uniquely and unambiguously traced to a cost object in an economic and convenient way. For example, the cost of glass to make a bottle is part of the direct cost of making the bottle. The cost of a warehouse acquired and used for the exclusive use of one product line is a direct cost to the product line.

The cost of material that becomes part of the cost object is called a *direct materials* cost. The cost of wood to make a piece of furniture is part of the direct materials cost of that piece of furniture.

Given this definition of direct materials, it would seem that the cost of items like glue and stain that are consumed to make a piece of furniture would also qualify as direct materials costs. However, it would be prohibitively expensive to track the amount of glue and stain used to make each piece of furniture. Instead, management accountants put the costs that tend to vary with some underlying level of activity (such as units produced, machine hours or labour hours) into a large cost pool and call them *variable overhead costs*. Management accountants then allocate costs from this cost pool using the activity measure. (Week 2, which discusses job order costing, will deal with the issue of allocating indirect costs in more detail.)

Labour uniquely associated with a cost object is called a *direct labour cost*. For example, the wage of a worker who is paid hourly to operate a piece of production equipment is a direct cost of the products produced on that equipment. As in the case of difficult-to-track direct materials costs, difficult-to-track direct labour costs (such as supervisors' salaries) are assigned to the variable overhead cost pool and allocated to cost objects using some activity measure.

Indirect cost

Any product cost that fails the direct cost test is treated as an *indirect cost*. For example, the salary of a sales manager is an indirect cost of all products the sales manager handles.

The classification of a cost as direct or indirect will depend on the cost object. If the cost object is a product made in a multi-product factory, the factory supervisor's salary will be an indirect cost. However, if the cost object is the factory itself, the factory supervisor's salary will be a direct cost.

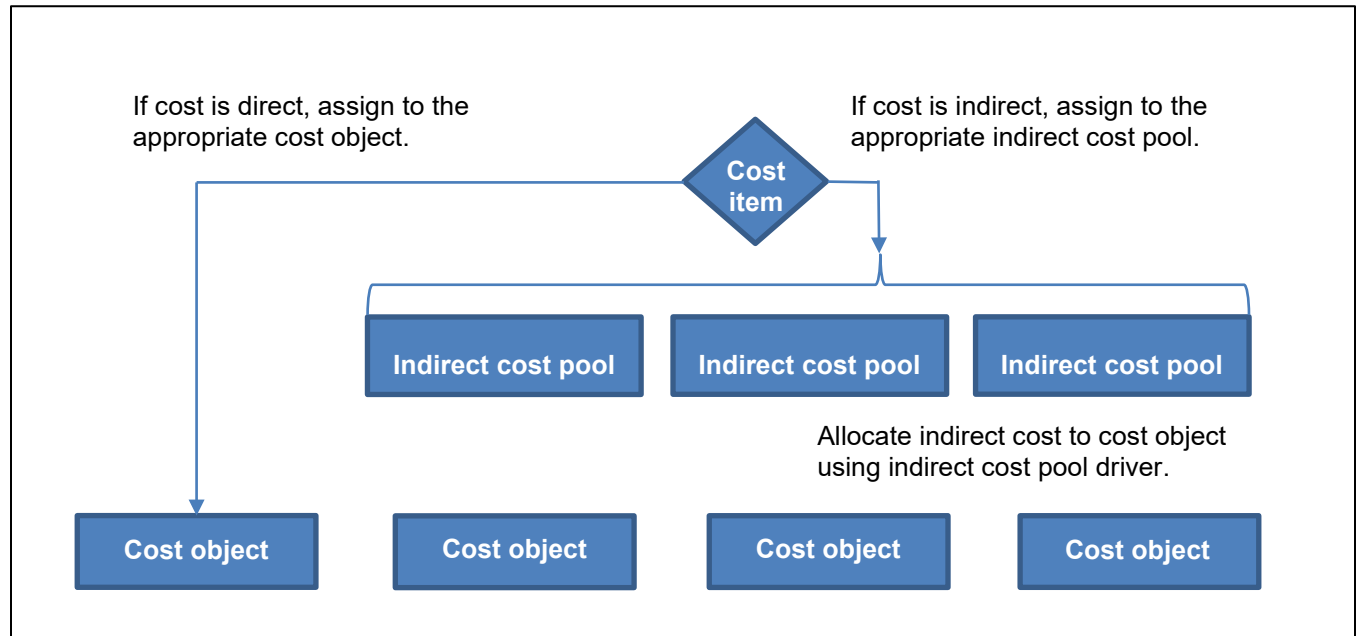
Assigned and allocated costs

Management accountants assign (or attribute) direct costs to a cost object and allocate the appropriate indirect costs to a cost object. Whether a cost is treated as direct or indirect can have important implications in contracts where the supplier is reimbursed

for cost plus a profit margin. Contractors frequently argue to have what is clearly an indirect resource, such as a piece of general-purpose equipment, treated as a direct resource for a project so that all the resource costs can be claimed for reimbursement.

1.2-3 Costing system architecture

With the terms introduced above, the management accountant can describe the architecture of any cost accounting system. The following diagram illustrates the process:



A cost is first classified as direct or indirect. If the cost is classified as direct, it is assigned or attributed (charged) directly to the appropriate cost object. If the cost is classified as indirect, it is assigned to the appropriate indirect cost pool. For example, a cost incurred during a setup might be assigned to an indirect cost pool accumulating all setup-related costs. Finally, indirect costs are allocated to the cost objects using some allocation rule. For example, setup costs might be assigned to a cost object based on the number of setups done to produce the cost object.

1.2-4 Cost terms used to describe and predict cost behaviour

Fixed cost

Understanding cost behaviour (fixed, variable and mixed) assists with cost estimation, which will be further explored in Topic 1.3. Management accountants use the term *fixed cost* for a cost that does not change in total over the planned range of an activity, which is referred to as the relevant range of activity. Fixed costs can also be called capacity-related costs because they only increase if management increases the capacity of operations. As a result, most capacity-related costs (such as depreciation on factory equipment) and supervisory costs are fixed costs. Fixed costs can be direct or indirect

costs. Fixed manufacturing costs are usually called fixed manufacturing overhead. There are many non-manufacturing fixed costs, such as selling and administration fixed costs.

The amount of capacity acquired determines the level of fixed costs associated with a resource. The amount of capacity acquired is called the *driver* for the resource's fixed cost. For example, the size of a manufacturing plant drives the fixed depreciation and property tax expenses for years to come. You will learn more about capacity and costing in Week 2.

Variable cost

Total *variable cost* is a cost that increases in constant proportion with changes in activity level while the cost per unit stays the same within the relevant range of activity. The formula for a variable cost is:

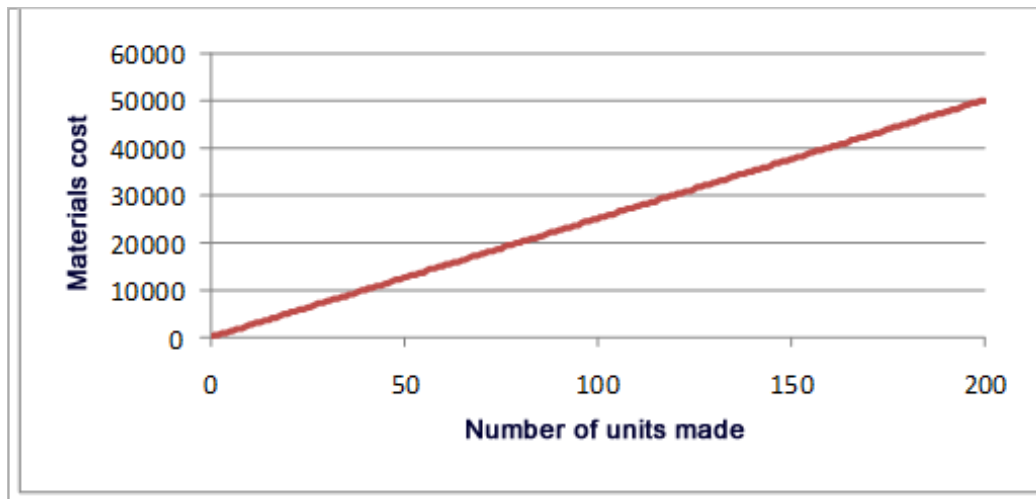
Total variable cost = variable cost per unit of activity × number of units of activity

Management accountants call the number of units of activity the *cost driver*. Sample variable costs and their cost drivers are:

Variable cost item	Cost driver
Setup	Number of setups
Factory supplies	Number of machine hours
Materials	Number of units made
Materials handling	Number of material moves
Manufacturing labour	Number of hours worked
Product support	Number of products
Hospital linen costs	Days beds occupied

When management accountants use the term *variable cost*, they usually mean total variable cost. When they are referring to the variable cost per unit of the cost driver, they usually say *variable cost per unit*.

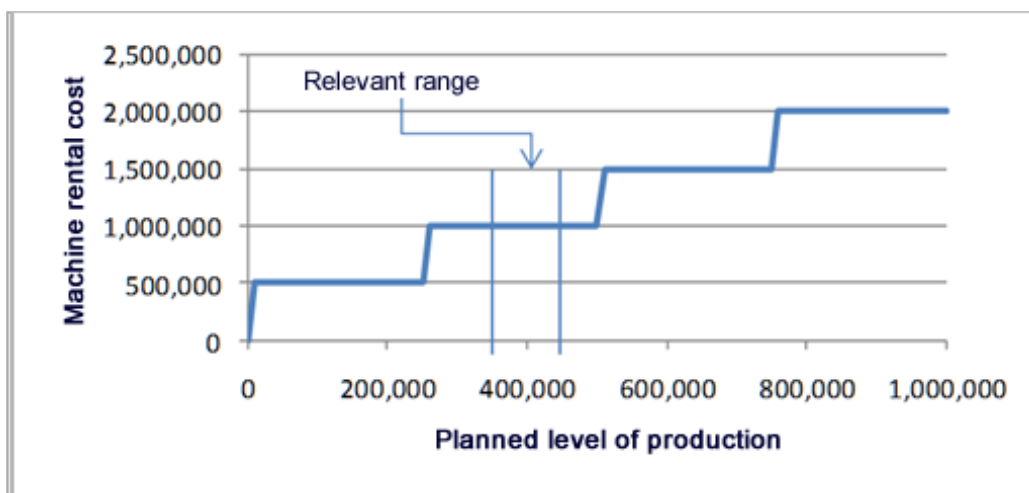
Note that this equation for variable cost assumes that the variable cost per unit of activity remains constant. Therefore, the variable cost chart will always be a straight line coming out of the origin with a constant slope. So, if the materials cost per unit is \$250, the variable cost graph will look as follows:



Relevant range

Most fixed costs will change if the underlying cost driver changes enough. For example, suppose an organization uses a piece of production equipment that is rented at a cost of \$500,000 per year. This production equipment has a capacity of 250,000 units. The cost driver for rental costs is the amount of the production equipment rented, which in turn depends on the planned level of production. Thus, the cost driver for rental costs would be the planned level of production.

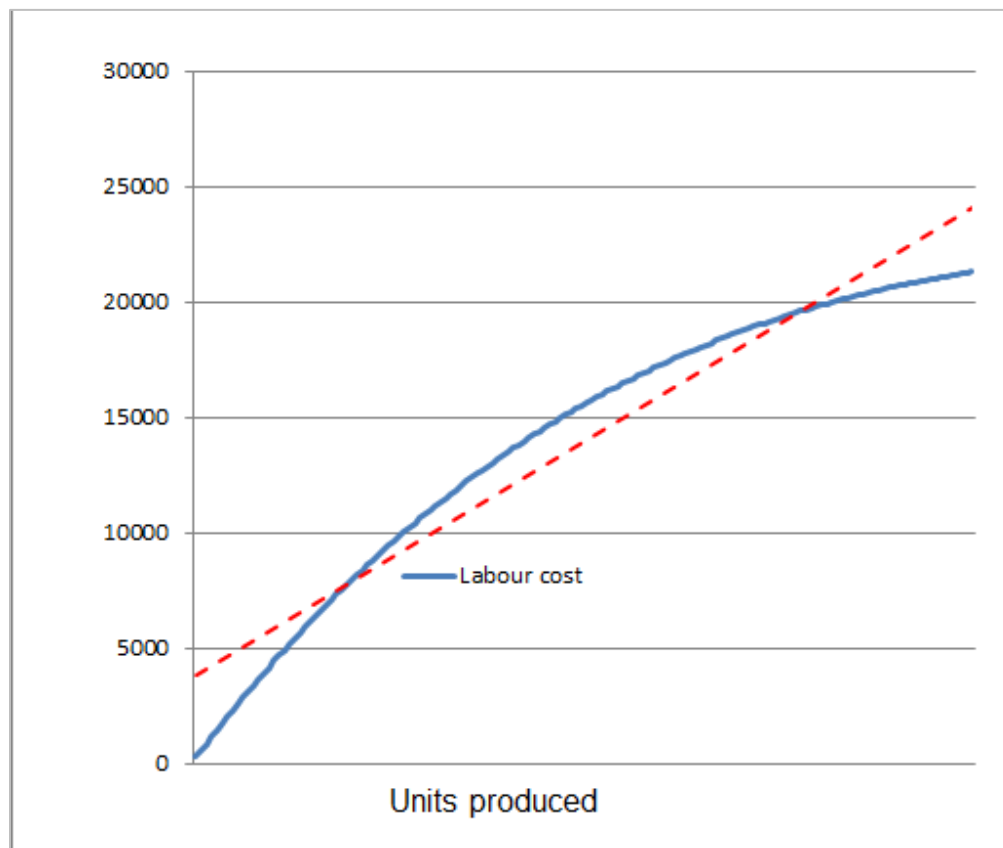
The following graph shows this equipment's rental costs for production between 0 and 1,000,000 units, assuming that an additional piece of equipment is rented for each additional 250,000 units of planned production. Management accountants call a cost that behaves like this a *step cost*.



Suppose management is planning for a production level between 350,000 and 450,000 units. In this case, management would rent two machines, and the rental cost would be \$1,000,000, which is a fixed cost over the relevant range of production of 350,000 to 450,000 units.

Management accountants also use relevant range when they are working with variable costs. Relevant range is used in settings where the variable cost per unit is not constant.

Suppose, for example, there is a learning effect such that the labour cost per unit begins at \$300 and steadily declines at a rate of 0.5% per unit for the first 150 units and then remains constant, as shown by the solid line in the following graph. This cost is curvilinear. What management accountants often do in this situation is restrict their attention to a relevant (planned) range of activity, such as between 100 and 150 units, and assume that the variable cost per unit in this range is constant, resulting in the variable cost line shown as the dotted line in the graph.



Step fixed cost

A *step fixed cost* occurs when the cost is constant over a relevant range of capacity or consumption but changes at regular intervals of activity. For example, a delivery company may lease its delivery vehicles, and each vehicle is capable of making 20,000

deliveries per year. Here, the lease cost must be incurred in one-vehicle increments when deliveries are greater than 20,000.

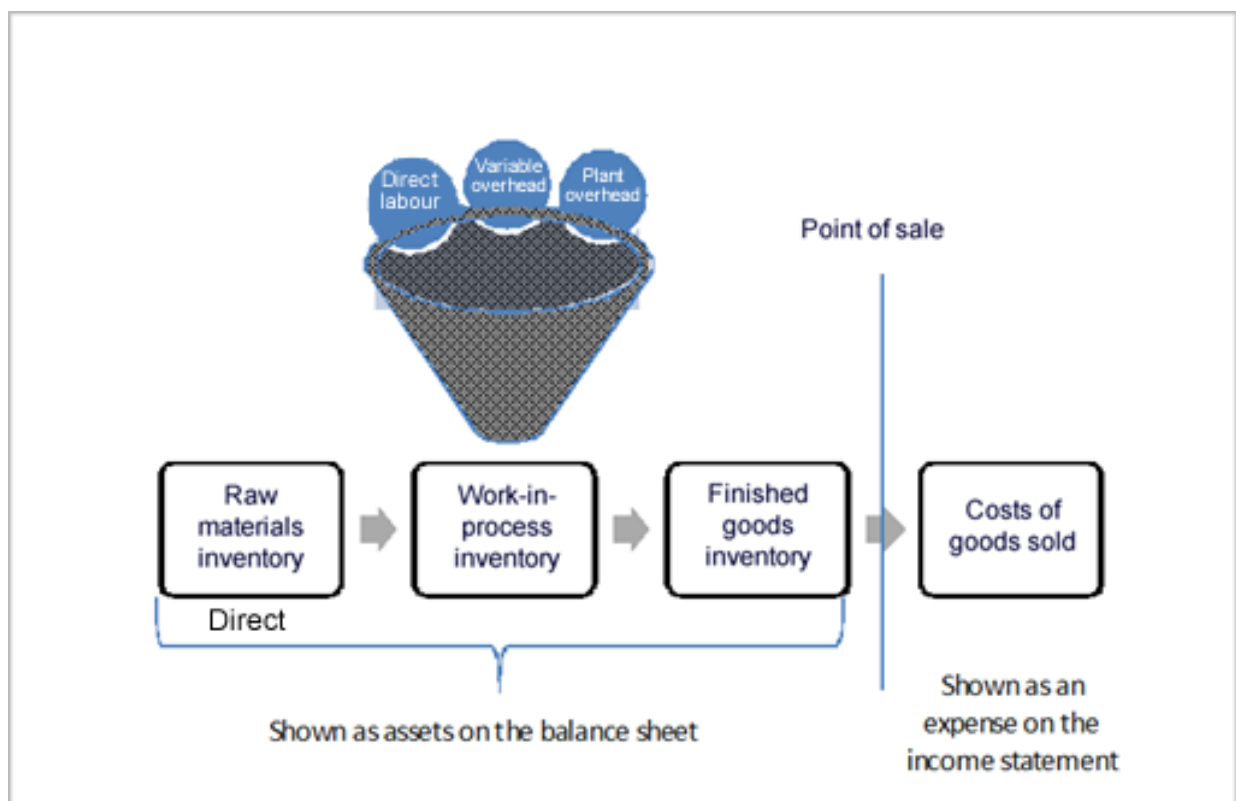
Step variable cost

A *step variable cost* is similar to a step fixed cost, but the range over which the cost is constant is fairly small. For example, setup costs may be incurred for each batch of 100 units. The cost is constant for a very small range of activity. Usually, step variable costs are assumed to be linear.

1.2-5 Cost terms used in manufacturing costing systems

Cost flows in manufacturing systems

The following diagram illustrates the flow of costs in manufacturing systems:



The costing process begins when raw materials enter into production and become part of the work-in-process inventory. The accountant increases the work-in-process inventory account by the costs of the raw materials transferred in and decreases the balance of the raw materials inventory account by the corresponding amount.

As the product is produced, more raw materials may be consumed, and their costs are added to the work-in-process account and deducted from the raw materials inventory account. Direct labour costs are added to work-in-process as incurred, and variable and

fixed manufacturing overhead costs are allocated to work-in-process, increasing the balance of the work-in-process account with corresponding accounting entries to the appropriate liability or asset adjustment accounts.

When the manufacturing process is complete, the management accountant transfers the accumulated costs of work-in-process to finished goods inventory and reduces the work-in-process inventory by the corresponding amount. When the product is sold, the product's cost is reflected as an expense on the income statement as cost of goods sold and deducted from the finished goods inventory account.

Prime costs

Accountants refer to the direct costs used to manufacture a product as its *prime costs*. Therefore, for most manufacturing operations, prime costs include direct materials and direct labour. Prime costs are particularly important in organizations where a major component of a product's total cost is material and labour — for example, in a craft operation requiring expensive raw materials or in food processing industries. If the organization chooses to track other resources that a product consumes during production, such as factory supplies and electricity, these would also be treated as prime costs.

Conversion costs

Accountants refer to all manufacturing costs other than direct materials costs as *conversion costs* since these costs are required to transform direct materials into the final product. Conversion costs include direct labour costs, variable manufacturing overhead costs, and fixed manufacturing overhead costs.

Schedule of costs of goods manufactured

Accountants summarize manufacturing costs in the schedule of costs of goods manufactured. The schedule provides a comprehensive view of the flow of costs in a manufacturing organization. The format of this schedule is as follows:

Schedule of costs of goods manufactured

Direct materials		
Beginning direct materials inventory	\$ 150,000	
Add: purchases of direct materials	<u>1,450,000</u>	
Direct materials available	1,600,000	
Deduct: ending direct materials inventory	<u>225,000</u>	
Direct materials transferred to work-in-process		\$1,375,000
Direct labour		750,000
Manufacturing overhead		
Indirect labour	85,000	
Supervisory labour	510,000	
Consumables (lubricants, drill bits, and so on)	175,000	
Utilities (heat and power)	1,125,000	
Depreciation of factory equipment	735,000	
Taxes on factory property	<u>125,000</u>	
		<u>2,755,000</u>
Total manufacturing costs		4,880,000
Add: beginning work-in-process inventory		<u>575,000</u>
		5,455,000
Deduct: ending work-in-process inventory		<u>424,000</u>
Cost of goods manufactured		<u>\$5,031,000</u>

Since the schedule of costs of goods manufactured summarizes manufacturing costs, it is a summary of work-in-process activities. The sum of direct materials, direct labour, and various overhead items equals the amount of manufacturing costs incurred in this period. These costs are added to the opening balance of work-in-process and ending work-in-process inventory is deducted to yield the cost of the work-in-process completed and transferred to finished goods inventory in this period. For competitive reasons, organizations rarely share the schedule of costs of goods manufactured with outsiders.

Note that the sum of the totals for direct materials and direct labour equals prime cost, in this case \$2,125,000 (1,375,000 + 750,000). The sum of the totals for direct labour and overhead equals conversion costs, in this case \$3,505,000 (750,000 + 2,755,000).

The cost of goods manufactured is not the cost of goods sold. The following statement shows how the cost of goods manufactured is used to compute the cost of goods sold:

Statement of cost of goods sold

Finished inventory	
Beginning finished goods inventory	\$1,175,000
Add: cost of goods manufactured	<u>5,031,000</u>
Goods available for sale	6,206,000
Deduct: ending finished goods inventory	<u>945,000</u>
Cost of goods sold	<u>\$5,261,000</u>

The cost of goods sold is the amount that is deducted from (matched with) the sales for the period to determine the gross margin, which is the amount of revenue left to cover non-manufacturing expenses and provide a profit.

1.2-6 Cost terms used in planning and control

Controllable versus non-controllable costs

Accountants have developed the terms *controllable* and *non-controllable costs*, which they use when evaluating performance.

These cost terms appear in the context of responsibility accounting, where a manager is accountable for controlling the costs in a unit of an organization. An important concept in responsibility accounting is the controllability principle, which argues that managers should not be held accountable for costs they do not control.

For example, the cost of fuel, which is affected by global demand and supply for oil, is a major component of cost in a courier company. Therefore, a manager in a courier company might agree that the cost of fuel is non-controllable and should not be part of the evaluation of how well they control costs. The amount of fuel consumed, however, may be controllable, and thus the manager may be accountable for this.

Some people have argued against the controllability principle, believing that it causes people to be reactive rather than proactive in controlling costs. For example, with the expectation of an increase in fuel prices, the proactive manager could sign a contract fixing the price of fuel.

Discretionary versus engineered costs

Accountants refer to costs subject to periodic budget allocations as *discretionary costs*. Advertising, and research and development costs are two examples of discretionary costs.

Accountants refer to costs driven by production levels, such as materials costs, labour costs, and the cost of machinery, as *engineered costs*. They are engineered in the sense that an organization cannot avoid these costs when undertaking production.

Because there is a cause-and-effect relationship between activity levels and engineered costs (for example, materials costs and machinery costs would be expected to increase in proportion to the production level), it is relatively straightforward to evaluate how well the organization has controlled engineered costs. The accountant can compare the actual amount of an engineered cost with an estimate of what it should be and decide whether the cost appears to be under control.

Note that selling and customer service costs can also have a cause-and-effect relationship with sales, and when they do, they are engineered costs. Engineered costs are not just manufacturing costs.

The challenge with discretionary costs is that the cause-and-effect relationship is hard to estimate. Management accountants struggle with how to evaluate the efficacy of spending on discretionary items such as advertising, maintenance, research and development, employee training, and performance rewards, since it is difficult to evaluate how the expenditures in these areas affect organizational performance.

1.2-7 Cost terms used in decision-making

Opportunity cost

An *opportunity cost* is the benefit forgone when a resource is used for one purpose instead of another.

For example, suppose there are 100 hours of machine time available. This machine time can be used to produce 50 units of Product A, which would produce an increment to profit of \$1,000, or 75 units of Product B, which would produce an increment to profit of \$1,200. This \$1,200 is the profit that could have been earned had the company produced Product B; however, if it chose Product A, this profit is “lost” and is considered an opportunity cost. The opportunity cost of using the machine time to produce Product B is \$1,000, that is, the lost profit from not producing Product A. Resources should always be allocated to the alternative that has the lowest opportunity cost, which in this case is Product B. As you can see from this example, maximizing profit or minimizing opportunity cost will result in the same decision.

Sunk cost

A *sunk cost* is a cost that has already been incurred and cannot be changed by any decision made now or in the future. Any cost that has already been incurred is a sunk cost. For example, if a company just paid \$2,000,000 to install a new production system, that cost is a sunk cost and would not be relevant to a decision to replace the production system tomorrow. Regardless of whether the system is replaced or not, \$2,000,000 has already been incurred. (What the system could be sold for would be relevant, but the \$2,000,000 that has already been paid would not.)

Sunk costs are important because they cannot be changed by any decision subsequent to the acquisition. Sunk costs should play no role in evaluating current decisions because they cannot be reversed.

Relevant cost

A *relevant cost* (or revenue) is a cost (revenue) that differs among the alternatives being considered and that will be incurred in the future. (Relevant costs will be further discussed in Week 6.)

Committed cost

A *committed cost* is a cost that is unavoidable for a certain period of time. A contractual lease payment is an example of a committed cost, as is depreciation on buildings and equipment. By their nature, decisions creating committed costs give rise to organizational risk, since they cannot be avoided in periods of financial distress.

TOPIC 1.3: COST ESTIMATION

Learning objectives:

- Outline the cost estimation process.
- Calculate estimated costs using judgment approaches and data approaches.
- Explain the limitation of using historical data to estimate costs.

In Topic 1.2, you studied different cost terms that management accountants use for different purposes. In Topic 1.3, you will study various techniques for estimating costs that management accountants use to assist with organizational planning. Management accountants apply these tools to understand cost behaviour and estimate costs.

The cost estimation process is as follows:

1. Determine the cost to be estimated, predicted, or understood.
This is the dependent variable. Examples include manufacturing overhead cost, materials cost, labour cost, and even total product cost.
2. Select a cost driver(s) that is believed to cause the cost that is being analyzed.
The cost driver needs to be both economically plausible and measurable.
3. After collecting relevant data, apply one of the judgment or data approaches discussed below to estimate the cost function.

Assuming that the resulting cost function reflects a linear relationship between the cost driver and the measured cost, the result of the estimation process will be a cost function as follows:

Total cost = fixed cost + (variable cost/unit of cost driver × units of cost driver)

Or the common linear equation called the cost function:

$$Y = a + bX$$

Where:

a = Y-intercept or fixed cost

b = slope or variable cost

Note that a linear cost function can result in a variable cost ($a = 0$), a fixed cost ($b = 0$) or a mixed cost ($a, b \neq 0$). As mentioned previously, there may also be cost functions that are non-linear, such as where there are learning or experience curve effects (for example, if the rate of increased production is less than the rate of increased costs). For simplicity and because accountants normally assume linearity throughout the relevant range, this discussion is limited to linear cost functions.

There are six common approaches to estimating costs: three involve the basic application of process knowledge and judgment, and three involve the use of historical data.

1.3-1 Judgment approaches

The three judgment approaches below apply slightly different but equally comprehensive understandings of the process that creates the cost to develop a plausible model of explaining the cost behaviour.

1. Engineering estimates

The *engineering estimate* approach involves estimating costs based on an analysis of product (good or service) specifications. This approach follows in the tradition of Frederick Taylor's scientific management method and the industrial engineering ideas developed by Frank and Lillian Gilbreth. In the engineering estimate approach, all required material, labour time and machine time components of the product are laid out, and the cost of each is estimated. Then the costs of all the components are summed to estimate the product costs.

2. Account analysis

Account analysis involves evaluating each of the costs in a ledger account and classifying each cost as fixed or variable with regard to a cost driver.

For example, a study of the items in the manufacturing overhead account might lead the cost analyst to classify supplies as variable, machine depreciation as fixed, supervisory salaries as fixed, taxes on factory land as fixed, power as variable, and so on. The cost analyst would then accumulate the classified costs into two pools, variable and fixed costs, to create an equation estimating cost behaviour.

3. Conference method

The *conference method* seeks opinions and analysis from the various relevant departments of the organization to develop cost estimates. For example, the purchasing and manufacturing departments would provide input on the various costs and cost drivers to help determine cost formulas. While cost functions can be quickly developed using this method, its accuracy depends greatly on the quality of the inputs from the various departments.

1.3-2 Data approaches

In the three data approaches (high-low, visual fit and statistical regression), the management accountant uses historical operations data to estimate cost behaviour. By considering the historical pattern of costs, the data approaches have the greatest potential to yield realistic estimates of cost behaviour. However, there are inevitable characteristics of historical cost data that can impair their relevance and usefulness in cost estimation.

The following examples illustrate the three data approaches:

Example 1.3a: High-low method used at Danny Co.

The data in the accompanying table for Danny Co. was recorded during the past 20 periods. Note that this data assumes the number of units made is the appropriate cost driver.

Observation	Units	Cost (\$)
1	812	145,300
2	586	139,650
3	845	151,125
4	863	151,575
5	852	146,300
6	698	147,450
7	610	135,250
8	614	145,350
9	642	136,050
10	836	140,900
11	759	143,975
12	693	137,325
13	553	133,825
14	512	127,800
15	707	147,675
16	802	145,050
17	635	135,875
18	629	145,725
19	773	139,325
20	872	146,800

In the *high-low method*, the management accountant computes the formula for the line connecting the lowest and highest values of the cost driver.

Therefore, the pair of observations that would form the basis for estimating the cost relationship would be:

Highest level of cost driver/cost — observation 20	872/\$146,800
Lowest level of cost driver/cost — observation 14	512/\$127,800

The slope of the line connecting the lowest and highest values of the cost driver is computed using the following formula:

Slope = cost assoc. with highest level of cost driver – cost assoc. with lowest level of cost driver

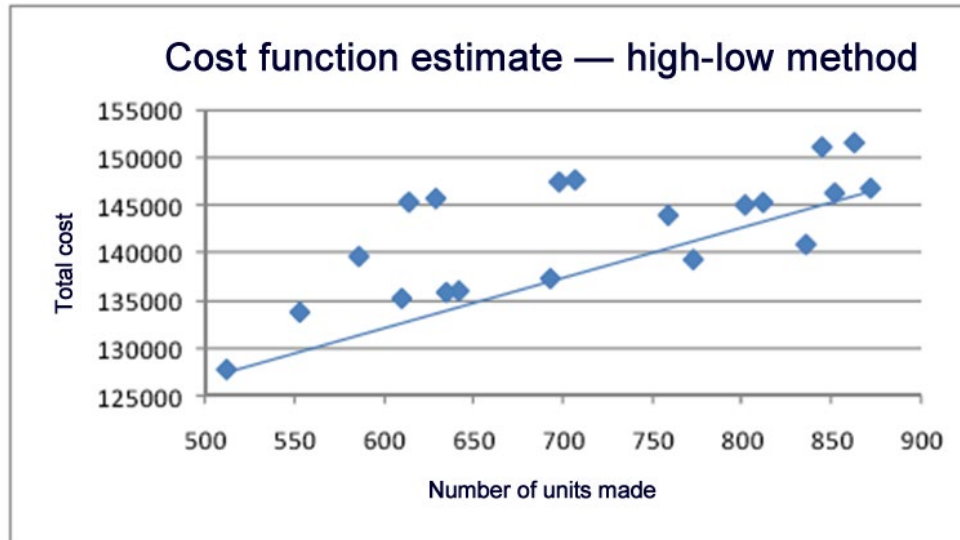
highest value of cost driver – lowest value of cost driver

$$= (146,800 - 127,800) \div (872 - 512) = 19,000 \div 360 = \$52.7778$$

The slope value is then substituted in either pair of observations to find the fixed cost estimate:

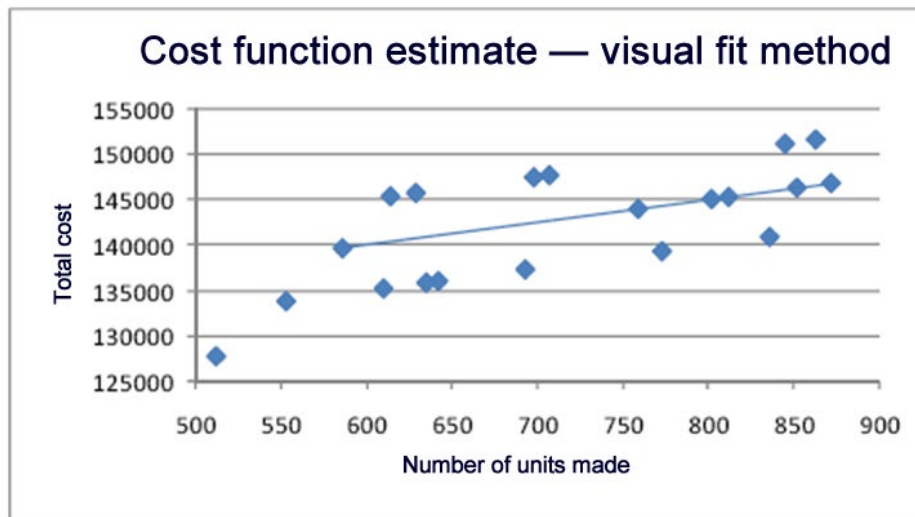
- High driver value observation fixed cost estimate:
 $Y = a + bX$
 Total cost = fixed cost + variable cost (units of cost driver)
 $146,800 = \text{fixed cost} + 52.7778(872)$
 $\text{Fixed cost} = 146,800 - 52.7778(872) = 100,778$
- Low cost observation fixed cost estimate:
 $127,800 - 52.7778(512) = 100,778$
 The estimate of the cost function using the high-low method is:
 Total cost = $100,778 + 52.7778 \times \text{number of units made}$

The following is a plot of the data showing the high-low estimate of the cost function:



The primary advantage of the high-low method is that it is easy and straightforward to apply. The major disadvantage is that it ignores all data except the two points used to develop the cost estimate, and it is possible that these end points are not representative of the data that has been gathered. A second disadvantage is that this approach can only be used with a single cost driver — in this case, the number of units made. (More on cost estimation with multiple cost drivers follows below.)

The second approach using cost data is the *visual fit method*. In this approach, the analyst draws a line through the data that seems to reflect the relationship between cost and the cost driver. This approach is particularly useful as an alternative to the high-low method if the end points in the high-low method do not appear to be representative of the other data. This approach is subjective and reflects the personal judgment of the analyst in fitting the line representing the cost equation to the data.

Example 1.3b: Visual fit method and Danny Co.

Suppose the analyst chooses the line shown in the figure above because it appears to pass through the centre of the data and chooses to ignore the observations associated with the lower levels of the cost driver on the grounds that there may be cost inefficiencies at lower production levels. The driver value/cost co-ordinates of the end points of the line shown in the figure above are 872/146,800 and 586/139,650. The cost estimation equation would be developed as follows:

$$\text{Slope} = \frac{\text{cost assoc. with highest units observed} - \text{cost assoc. with lowest units observed}}{\text{highest units observed} - \text{lowest units observed}}$$

$$= (146,800 - 139,650) \div (872 - 586) = 7,150 \div 286 = \$25$$

Substitute the slope value in either of the pair of observations to find the fixed cost estimate:

1. High cost observation fixed cost estimate = $146,800 - 25 \times 872 = \$125,000$
2. Low cost observation fixed cost estimate = $139,650 - 25 \times 586 = \$125,000$

The estimate of the cost function using visual inspection is:

$$\text{Total cost} = 125,000 + 25 \times \text{number of units made}$$

Note the significant difference between the two cost estimates:

High-low estimate: total cost = $100,778 + 52.778 \times \text{number of units made}$

Visual fit estimate: total cost = $125,000 + 25 \times \text{number of units made}$

This shows how sensitive these approaches are to the assumptions made when generating them.

The third approach is the formal statistical approach, which is used to estimate the statistical relationship in a set of data. This method considers all data (unlike the high-low method) and does not rely on subjective judgment (unlike the visual inspection method).

The *statistical regression approach* fits an equation to the observed data using the criterion of minimizing the sum of the squared differences between the values predicted by the regression equation and the original data. This “best-fit” criterion is summarized by the statistic R-square (R^2), which is a goodness-of-fit measure (called the coefficient of determination). This measures the amount of variability in the dependent variable that is explained by changes in the independent variable.

Example 1.3c: Statistical regression approach at Danny Co.

The first step in applying the regression model is to choose the cost to be estimated, called the dependent variable because it is assumed to be dependent upon the value of the cost driver(s). The second step is to choose the cost drivers, called the independent variables, which are assumed to cause the behaviour of the dependent variable. Note that the term *cost driver* implies a plausible causal relationship between the cost driver and the dependent variable.

In this case, the total cost is chosen as the dependent variable and the number of units made is chosen as the independent variable. This is a plausible relationship. Plausibility is important because you cannot infer causality from a high goodness of fit (R^2). A high goodness of fit only implies a statistical relationship between the dependent variable and the independent variable(s), not causality. For example, statistical studies indicate that sunspot activity on the surface of the sun is positively correlated with the performance of the New York Stock Exchange, but this doesn't mean that sunspot activity *causes* changes in the stock market's performance.

The third step in using regression is to plot the dependent variable (by convention on the y or vertical axis) against the independent variable (by convention on the x or horizontal axis). This determines where the relationship appears to be linear, since the linear regression model assumes the relationship between the two variables is approximately linear. This is the case in the high-low data plot for Danny Co., where the relationship of total cost to units produced is approximately linear.

The fourth step is to undertake the regression analysis. While there is specialized software for regression analysis, there are also reasonable regression tools in most spreadsheet packages, such as Microsoft Excel. Entering the data for this

problem into an Excel spreadsheet and applying regression analysis produces the following output:

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.722355489							
R Square	0.521797452							
Adjusted R Square	0.495230644							
Standard Error	4463.755739							
Observations	20							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1	391348268.5	391348268.5	19.640954	0.000322002			
Residual	18	358652075.3	19925115.29					
Total	19	750000343.8						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	113520.1868	6529.198022	17.38654371	1.064E-12	99802.8508	127237.5	99802.85	127237.5229
X Variable 1	40.01408126	9.02883181	4.431811568	0.000322	21.04520952	58.98295	21.04521	58.98295301

The estimated coefficients:

The regression model has estimated the following cost equation (taken from the coefficients column above):

$$\text{Total cost} = 113,520 + 40.0141 \times \text{units produced}$$

The fifth step is to interpret the regression results from the output, particularly the following two elements:

Goodness of fit (R^2)

Excel reports three goodness-of-fit measures for each regression:

1. Multiple R (also known as r or the *correlation coefficient*), which is a measure of correlation between the independent variable and the dependent variable. This can range between -1 (perfect negative correlation) and $+1$ (perfect positive correlation). The closer the value is to $+1$ or -1 , the better the correlation.
2. R-square, which is the correlation measure squared.

- Adjusted R-square, which is the R-square value adjusted for the number of independent variables. Statisticians believe the adjusted R-square is the best measure of association between the independent variable and the dependent variable, and it is the one that is used in this course. Adjusted R-square is interpreted as the proportion of variability in the dependent variable that is explained by the independent variable.

Therefore, the goodness-of-fit measure for this regression is 49.52%, which is the adjusted R-square measure. This means that 49.52% of the changes in the costs can be explained by the changes in the number of units.

The t-statistic

The t-statistic is used in a formal statistical test of the hypothesis that the coefficient associated with the independent variable is zero. If the absolute value of the t-statistic is greater than a critical value, we reject the null hypothesis that the true value of the coefficient associated with the independent variable is zero.

The formal statistical tests are not discussed in these notes. Instead, it can be assumed that, if the absolute value of the t-statistic is two (2.00) or greater, a statistically significant relationship exists between the independent variable and the dependent variable. In other words, the true value of the coefficient is not zero, and there is a relationship between the dependent variable and the independent variable (the assumed cost driver). The opposite will also hold true. If the absolute value of the t-statistic is lower than two (2.00), you would have no confidence that there is a statistically significant relationship between the independent variable and the dependent variable.

In this case, the value of the t-statistic associated with the estimated coefficient is greater than two; therefore, a relationship exists between units produced and total cost.

You are not expected to be able to produce a regression output in Excel. You are, however, expected to be able to create an equation that you can then use to estimate the given cost based on an Excel output. In addition, you should be able to explain the meaning of the various goodness-of-fit measures shown on an Excel regression analysis printout, including making a decision based on the t-statistic.

Limitations of historical cost data

When management accountants use historical cost data, they are assuming that there has been no underlying change in the manufacturing process that is not captured in the recorded data. Statisticians call this the omitted variable problem. The longer the period over which the recorded data stretches, the greater the possibility that there has been some change (such as in technology, product design, learning or inflation) that could affect costs, but which has not been picked up in the measurement process.

Another potential contaminant of historical cost data is inaccurate cost accrual. The shorter the cost recording period (for example, weekly or monthly), the greater the chance that accruals are less reliable and therefore misleading when estimating costs. For example, costs driven by an activity in one period might be inaccurately assigned to the next period.

Generally, management accountants are forced to rely on quarterly accruals to provide a minimum assurance of data integrity. This means they can make only four observations per year to develop the cost estimation database. Since the general rule is that a minimum of 20 observations are needed to provide a reliable cost estimate, this means five years of time-series data are needed to provide a reasonable database for a cost estimate. However, the five-year time period introduces the possibility of important changes in the manufacturing environment, such as a technological innovation that may have taken place but not been captured in the data, thereby creating errors in cost estimation.

In addition, the way the accounting system treats costs can create issues of data integrity. For example, if fixed costs are allocated to production based on an activity level, such as units made, labour hours, or machine hours, what is actually a fixed cost may appear to be variable.

Continuous growth also creates issues when using regression analysis. Using an estimated cost equation to predict costs beyond the range of experience (the relevant range) is inappropriate, since this can result in significant estimation errors.

Finally, there is the troubling issue of outliers, which are data points that are significantly different from the rest. These extreme points create issues in cost estimation, particularly when using regression analysis. The general treatment for an unusual item is to try to identify the cause of the observation. If the cause was a non-recurring item, such as a natural disaster or a strike, the usual approach is to eliminate the outlier from the data set. Most analysts will avoid eliminating an outlier from a data set if its cause cannot be determined, on the grounds that, if the outlier cannot be explained, then the circumstances that created it cannot be accommodated in cost estimation.

In summary, the general process for all data approaches is as follows:

1. Select the cost driver.
2. Collect data on the values of the independent and dependent variables (a minimum of 20 observations is preferable). The time period used to measure variables should be identical for both the independent and dependent variables.
3. Plot the data to determine if a linear relationship is plausible and if there are any outliers in the data.
4. Apply one of the data methods.

TOPIC 1.4: COST-VOLUME-PROFIT ANALYSIS

Learning objectives:

- Calculate the break-even point in sales and in units using the cost-volume-profit model.
- Calculate the margin of safety as a basic sensitivity analysis of the break-even analysis.
- Calculate the level of sales in dollars and in units required to achieve a given level of both before- and after-tax profit using the cost-volume-profit model.
- Assess what-if scenarios using the cost-volume-profit model.
- Calculate the break-even point in sales and in units for multiple-product situations.
- Explain the use of both big data and internal financial data in the preparation of scenarios for planning.

Cost-volume-profit (CVP) analysis is a tool that assists managers in understanding the relationship between revenues and costs and the effect of a change in either of these variables on the bottom line. Through isolating specific variables (price, volume, variable costs per unit, fixed costs and product mix), management accountants can understand how profit moves in relation to a change in any of these items. With the assistance of effective CVP analysis, managers can then make decisions regarding what product or mix of products to produce and what selling price and cost structure to use.

1.4-1 The cost-volume-profit model

The basic CVP model makes the following important assumptions:

- The volume of sales (for a single product or a set mix of products) does not affect product price.
- The volume of product does not affect variable cost per unit.
- All costs are either variable (direct and indirect) or fixed (direct and indirect).
- All product is sold.
- The behaviour of total revenues and total costs is linear in relation to output units within the relevant range of operations.
- All revenues and costs can be added or compared without taking into account the time value of money.

With these assumptions, the profit equation can be used to develop the CVP relationship, as outlined below.

Let:

P = price per unit

V = variable cost per unit

F = total fixed cost

x = number of units produced and sold

OI = operating income

Revenues – costs = operating income:

$$Px - Vx - F = OI$$

$$x(P - V) - F = OI$$

Accountants call price per unit minus variable cost per unit ($P - V$) the *contribution margin* (CM) per unit. The CM per unit is the dollar amount that each unit made and sold contributes to covering fixed costs and providing a profit.

The above equation can now be rewritten as:

$$xCM - F = OI$$

$$x = (\text{fixed costs} + \text{operating income}) \div \text{CM per unit}$$

For convenience, this equation can be called the CVP units equation. It allows the decision maker to identify the number of units (x) that must be made and sold to cover fixed costs (break-even point) and provide a target profit. Put another way, it predicts the profit (or loss) resulting from a given level of unit sales.

1.4-2 Using the cost-volume-profit units model

The following example illustrates the use of the CVP units model.

Example 1.4a: CVP at Russell Co.

Russell Co. sells a product that has a price of \$4 per unit, variable manufacturing costs of \$2 per unit and variable selling costs of \$0.50 per unit. Russell has fixed manufacturing costs of \$125,000 and fixed general, selling and administrative expenses of \$25,000. Assume management has two questions:

1. How many units does Russell have to sell to break even?
2. How many units does Russell have to sell to earn a pre-tax profit of \$100,000?

The total variable cost of the company's product is \$2.50 (\$2 + \$0.50). Therefore, the CM per unit is \$1.50 (\$4 – \$2.50). The company's total fixed costs are \$150,000 (\$125,000 + \$25,000).

Break-even means zero profit, so putting this data into the CVP units equation yields the following result:

$$\text{Units at break-even: } 150,000 \div 1.50 = 100,000 \text{ units}$$

The following equation computes the unit sales needed to generate a target profit of \$100,000:

$$\text{Units at profit of } \$100,000: (100,000 + 150,000) \div 1.50 = 166,667 \text{ units}$$

When a target quantity is computed, it is normally rounded up (to the nearest whole number) to calculate the solution. In those cases, multiplying the break-even quantity by the CM and subtracting fixed costs will result in a minimal profit. Because these figures are estimates used for decision-making, these minimal amounts should not have an effect on the final decision.

1.4-3 Sensitivity analysis for CVP

Sensitivity analysis examines how results change or if some of the initial assumptions change based on different levels of operation. Sensitivity analysis is also referred to as what-if analysis, because it looks at the effects of different possible outcomes on the analysis. Using computerized spreadsheets, it is possible to run various versions of CVP analyses for different scenarios, such as different levels of fixed costs or different levels of sales to meet levels of operating income. Sensitivity analysis attempts to address the uncertainties encountered by the management accountant. Uncertainty analysis will be discussed further in Week 6.

Management accountants often find the margin of safety measure useful for expressing financial risk as part of sensitivity analyses. The margin of safety measure compares the target sales level with the break-even sales level; it is computed as follows:

$$\text{Margin of safety} = \text{expected units} - \text{break-even units}$$

Or as a margin of safety percentage:

$$\text{Margin of safety percentage} = (\text{expected units} - \text{break-even units}) \div \text{expected units}$$

In the example above, assume that management believes the company will sell 150,000 units; the margin of safety is $150,000 - 100,000 = 50,000$ units. The margin of safety percentage is 33% ($50,000 \div 150,000$). The margin of safety percentage measure says that sales would have to drop at least 33% from expected levels before losses would occur.

1.4-4 Developing and using the revenue CVP model

Decision makers often prefer that the required levels to achieve break-even or a target profit be stated in revenue terms. The CVP units model can be adapted to the revenue perspective.

To do this, the CVP units equation is converted from a unit to a revenue equation by multiplying both sides of the equation by price per unit (P):

$$\text{Revenue} = Px = \frac{P(\text{operating income} + \text{fixed costs})}{\text{CM per unit}}$$

Dividing the top and the bottom of the right-hand side of the equation leads to the following:

$$\text{Revenue} = \frac{(\text{operating income} + \text{fixed costs})}{(\text{CM per unit} \div P)}$$

Management accountants call the ratio of CM per unit divided by price per unit the *contribution margin ratio*. The contribution margin ratio reflects the proportion of each sales dollar that goes toward covering fixed costs and providing a profit.

$$\text{CM ratio} = \text{CM per unit} \div P$$

Consider the following equation, which can be called the CVP revenue equation:

$$\text{Revenue} = (\text{operating income} + \text{fixed costs}) \div \text{CM ratio}$$

In the Russell Co. example, the product's contribution margin ratio is therefore computed as follows:

$$\$1.50 \div 4 = 37.5\%$$

The following questions can now be answered in revenue terms for the above product:

- What sales revenue must Russell achieve to break even?
- What sales revenue must Russell achieve to earn a profit of \$100,000?

The first question can be answered with the following calculation:

$$\$150,000 \div 37.5\% = \$400,000$$

How does this compare with the break-even in units calculated above? Break-even in units was 100,000 units, which at \$4 per unit is \$400,000.

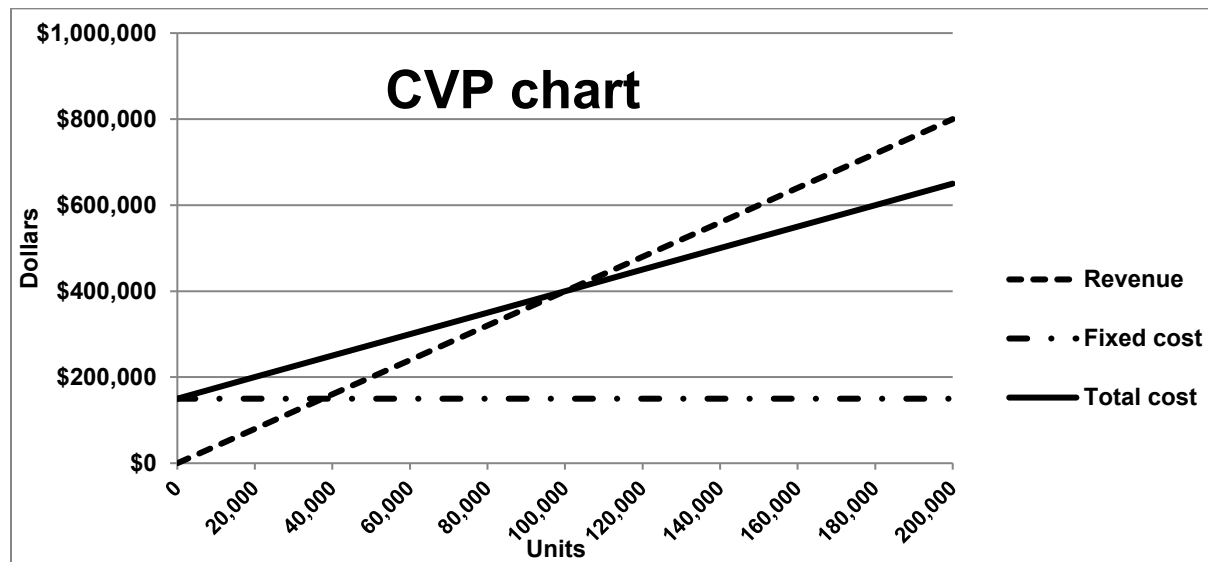
The second question can be answered with the following calculation:

$$(\$150,000 + 100,000) \div 37.5\% = \$666,667$$

How does this compare with the per-unit calculation? The per-unit calculation equalled 166,666.6666, which at \$4 per unit equals \$666,666.67 or \$666,667.

1.4-5 The CVP chart

Management accountants often find it useful to express the CVP relationship in a CVP chart. The CVP chart for the product described above would be as follows:



The advantage of the CVP chart is that it provides a visual representation of units, revenues, costs, and profits, which often helps communicate these relationships more effectively. Note that the slope of the total cost line is the variable cost per unit.

1.4-6 Taxes and the CVP equations

Consider the basic profit equation:

$$\text{After-tax profit} = [(\text{revenue} - \text{variable cost}) - \text{fixed cost}] \times (1 - \text{tax rate})$$

Or, using the notation developed above:

$$\text{After-tax profit} = [(P - V)x - F] \times (1 - \text{tax rate})$$

Remember that $(P - V)$ is the unit CM; therefore, the CVP unit equation can be adapted for taxes:

$$x = [\text{after-tax profit} \div (1 - t) + \text{fixed costs}] \div \text{CM per unit}$$

This equation converts the after-tax profit to before-tax profit using the CVP unit equation.

Following the same procedure used above, a CVP sales equation can be developed:

$$\text{Revenue} = \{[\text{after-tax profit} \div (1 - t)] + \text{fixed costs}\} \div \text{CM ratio}$$

Example 1.4b: CVP and taxes at Russell Co.

Russell Co. faces a tax rate of 30%. How many units must Russell sell to earn a post-tax profit of \$100,000?

In units:

$\{[100,000 \div (1 - 30\%)] + 150,000\} \div 1.5 = 195,238.1$ or 195,239 units (rounded up)

Or, in revenue:

$[(100,000 \div 70\%) + 150,000] \div 37.5\% = \$780,952^*$

*Because the quantity in units to sell to achieve a post-tax profit of \$100,000 was rounded up, it would also be correct to say that the sales dollars required would be $195,239 \times \$4$, or \$780,956.

1.4-7 Using the profit equation for what-if analysis

The profit equation provides a financial model of the organization. Manipulating the profit equation allows management to undertake analyses to predict the effect of proposed decisions — a process called what-if analysis.

Example 1.4c: CVP, what-if and Russell Co.

Given the data above, assume that Russell Co. management expects unit sales of 160,000 for the upcoming period. The marketing manager believes that a 5% price decrease and a \$25,000 advertising budget will increase sales to 175,000 units. Are these changes desirable?

Incremental analysis can be used to calculate the incremental income of the proposed changes as follows:

Total CM	
Before: 160,000 units × \$1.50	\$240,000
After: 175,000 × \$1.30*	<u>227,500</u>
Incremental contribution margin	(12,500)
Advertising costs	<u>(25,000)</u>
Incremental income (loss)	<u>\$(37,500)</u>

*Sales price decrease = decrease in CM/unit = $\$4 \times 5\% = \0.20

New CM/unit = $\$1.50 - 0.20 = \1.30

Clearly, these proposed changes should not be made, as they would decrease the company's income by \$37,500.

1.4-8 Multi-product CVP analysis

Many assumptions are made in CVP analysis, including assumptions about constant prices, variable costs, and fixed costs. To adapt the CVP models to a multi-product operation (where more than one product is produced by the same company), assume that, as total sales levels increase or decrease, each product's proportion of total sales remains constant.

The following example illustrates the approach and the insights of multi-product CVP analysis.

Example 1.4d: Multi-product CVP and Brant Consulting

Brant Consulting designs graphing and statistical systems for its clients. The following is a summary of volume, revenue and cost expectations for the upcoming year:

	Graphing (50 projects)		Statistical (75 projects)		Firm total
	Per job	Total	Per job	Total	
Revenue	\$10,000	\$500,000	\$15,000	\$1,125,000	\$1,625,000
Variable cost	<u>4,500</u>	<u>225,000</u>	<u>11,500</u>	<u>862,500</u>	<u>1,087,500</u>
Contribution margin	\$ 5,500	\$275,000	\$ 3,500	\$ 262,500	\$ 537,500
Fixed cost					<u>475,000</u>
Profit					<u>\$ 62,500</u>

The organization would like to know the number of each product to sell to break even.

To solve this problem, first combine units in a bundle based on the projected sales mix. In this case, the sales mix is 50 graphing projects (GP) and 75 statistical projects (SP). At its lowest common denominator, the sales mix is two units of GP to three units of SP (2GP:3SP).

Then create a product bundle containing two GP and three SP and calculate the CM generated by that bundle:

$$(2 \times \$5,500) + (3 \times \$3,500) = \$21,500$$

The number of bundles needed to be sold to break even is:

$$\$475,000 \div 21,500 = 22.1$$

You can't sell part of a bundle, so that means you need to sell 23 bundles.

Then break out the bundles into the individual products:

$$\text{GP: } 23 \text{ bundles} \times 2 = 46$$

$$\text{SP: } 23 \text{ bundles} \times 3 = 69$$

The number of bundles Brant Consulting needs to sell to achieve an operating income of \$60,000 is:
 $(\$475,000 + 60,000) \div 21,500 = 24.88$

Again, you can't sell part of a bundle, so you need to sell 25 bundles.

Breaking out the bundles into the individual products:

GP: 25 bundles \times 2 = 50

SP: 25 bundles \times 3 = 75

Because you have had to round up, this does not work out to a profit of exactly \$60,000. Instead, total operating income would be \$62,500 $\{[(50 \times \$5,500) + (75 \times \$3,500)] - \$475,000\}$.

One problem with the CVP analysis described above is that it makes assumptions about the behaviour of costs and applies those assumptions indefinitely even though these behaviours hold only for a period of time. A second problem is that bundling assumes the ratio of products will be the same at all levels of sales. Management accountants need to factor these considerations into their detailed CVP analyses to ensure the variables used reflect the period and volume in which they are making decisions.

1.4-9 Spreadsheets

The model used for CVP analysis can be simulated using an Excel spreadsheet. The use of Excel and other tools designed to simulate the interrelationships of business costs and processes is called business modelling. Using these tools also allows the user to visualize the data through charts. Excel can also be used as a data analytics tool to draw inferences on data and make predictions.

1.4-10 Scenario planning

While management accountants are quite comfortable using techniques such as CVP analysis to assess possible courses of action, many other variables often interact to cause unexpected results. Scenario planning is a strategic business planning method that recognizes that many factors may combine in complex ways to generate unexpected future results. It divides business knowledge into two groups: elements the business knows with reasonable certainty and elements that are uncertain or unknown.

For example, a business knows about its cost structure or its market demographics, but these known items interact with unknown elements, such as interest rates, fads, trends, or competitor innovation, to create various business scenarios. This blending of the known and the unknown into a limited number of internally consistent future scenarios is the essence of scenario planning and will often yield insights that were previously hidden.

Big data plays a role in scenario planning by making available the vast amount of data required to develop scenarios that effectively model the future. Consider a company

planning to offer its products in another country. Not only should it consider the cost of manufacturing the product locally versus internationally; it should also consider the political, economic, social, technical, and environmental uncertainties. Additionally, it should be able to make reliable predictions about how each of these factors can affect the ongoing success of this venture.

Using data analytics tools, like Power BI, the network of data available via big data can assist in developing scenarios that help to assess the risks involved in these types of decisions. It accomplishes this by pulling in data that is constantly updated in real time from multiple sources and in multiple data formats.

Management accountants play an important role by developing the inputs to these scenario planning models. They must understand the interrelationships of data that will be used, including the drivers of the data, its impact on the decision, and the level of certainty with which the predictions are made. Along with the help of data scientists, who assess the relationships of the data, they can evaluate the scenarios generated by the model. At this level, the management accountant can help make strategic decisions affecting the organization further into the future. The addition of artificial intelligence takes scenario planning one step further by making predictions based on questions the user had not anticipated.

1.4-11 Descriptive, predictive, and prescriptive data analytics

Data analysis is often classified as one of three levels: descriptive, predictive, or prescriptive.

Descriptive analytics focuses on historical data to find trends and compare metrics, such as variances over a period of time. This could include looking at the change in commodity prices or even tabulating “likes” on Facebook in relation to a product.

Predictive analytics takes descriptive analytics one step further by analyzing trends in historical data to predict the future. Cost estimation using the high-low method is an example of predictive analytics. Predictive analytics is commonly used in online retail, such as when deals pop up in website ads after recent related searches on shopping sites.

Prescriptive analytics, which is a growing field in data analytics, uses tools such as data mining and artificial intelligence to provide or prescribe the best possible solution. Autonomous or self-driving cars are an example of prescriptive analytics, as these vehicles make decisions using data and sensors.

Example 1.4e: Boston Bar Chocolate Company

Boston Bar Chocolate Company (BBCC) is a privately owned organization that produces healthy chocolate bars. The company’s management team is constantly reviewing data to ensure its products are manufactured using the best

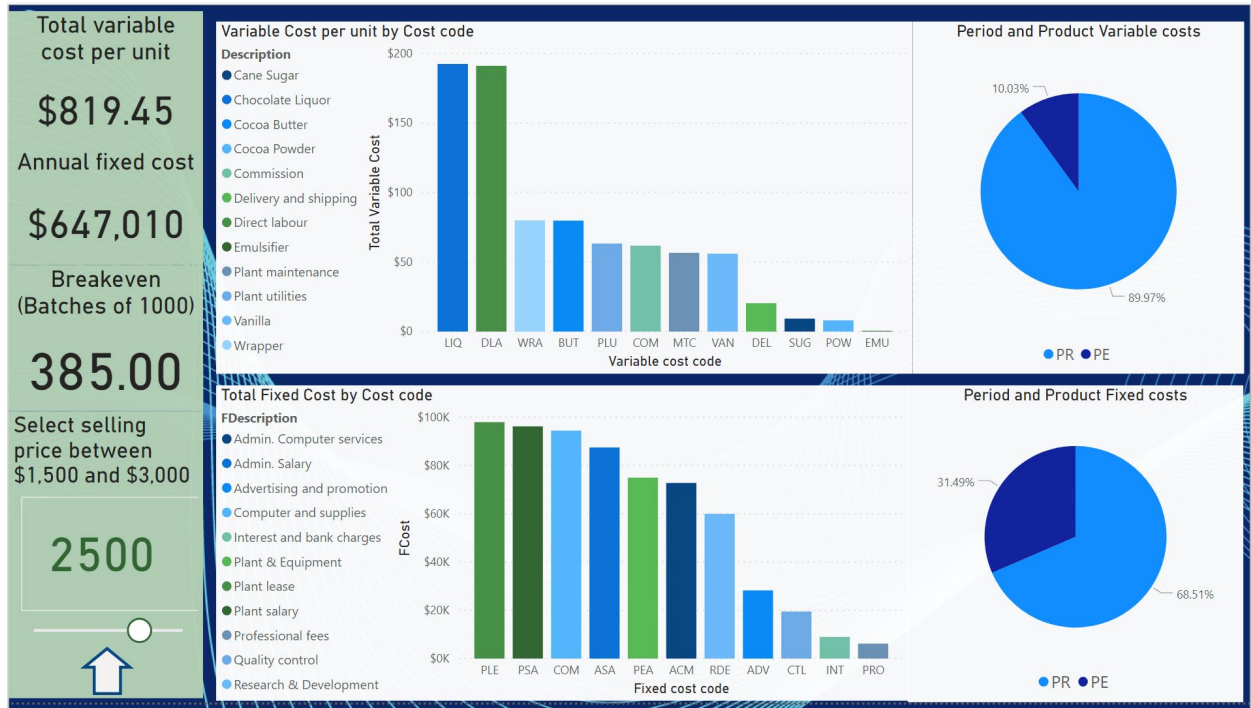
ingredients at reasonable costs. Along with customer feedback, management reviews ingredient costs and margins on a regular basis.

The company could use *descriptive analysis* to monitor the prices of ingredients. This is usually sourced using external data. For example, Markets Insider (a stock market site that provides real-time market quotes) contains information on cocoa prices in real time and illustrates the cost trend for cocoa. The management team could simply monitor costs of cocoa in relation to supplier costs. However, management could also create a dashboard combining the commodity costs and the costs of the top three suppliers, which can be updated in real time. More and more websites like Markets Insider are making their data available to download for analytics. BBCC might track the price of cocoa using the following site: <https://markets.businessinsider.com/commodities/cocoa-price>.

Combining this with other real-time data (ultimately from suppliers of all costs) allows BBCC to build a real-time cost-volume-profit analysis tool using PowerBI, shown below. The tool consists of a visualization of variable costs and fixed costs for the period. It illustrates the relational volume of each of the costs and organizes it into product and period costs. If linked to supplier prices in real time, it also gives an up-to-date illustration of break-even costs.

At the bottom left corner of the illustration is a slider bar that allows the user to predict break-even sales based on the selling price per batch of 1,000 bars. This what-if analysis is an example of predictive analytics.

This week's practice problems go through the steps required to create this dashboard using a set of data.



More sophisticated tools would be required to turn this example into an illustration of prescriptive analytics. In this situation, an example of prescriptive analysis would be allowing the data analytics tools to assess a number of factors and determine which suppliers to use and the best selling price for the product. This would require the input of tolerance ranges for key performance indicators such as cost, availability and quality of inputs, and elasticity of demand. Prescriptive analytics is a growing field in data analytics; however, the tools used are beyond the knowledge required for this course.

WEEK 1 SUMMARY

The following is a list of the competencies from the CPA Competency Map that pertain to this week's subject matter identified by their number in the map. For more information on the CPA Competency Map, see the CPA Canada website (<https://www.cpacanada.ca/en/become-a-cpa/pathways-to-becoming-a-cpa/national-education-resources/the-cpa-competency-map>).

Competencies:

- 3.1.1 Evaluates management information requirements.
- 3.1.2 Documents and assesses business processes, systems, and data requirements.
- 3.2.1 Develops or evaluates data and information inputs for operational plans, budgets, and forecasts.
- 3.2.2 Prepares, analyzes, or evaluates operational plans, budgets, and forecasts.
- 3.3.1 Evaluates cost classifications and costing methods for management of ongoing operations.
- 3.3.2 Evaluates and applies cost management techniques appropriate for specific costing decisions.
- 3.5.1 Performs sensitivity analysis.
- 3.5.2 Evaluates sustainable profit maximization and capacity management performance.
- 3.6.1 Evaluates performance using accepted frameworks.