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F5 Study Text
Performance Management

ACCA

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Paper F5

Performance management

Welcome to Emile Woolf's study text for Paper F5 *Performance management* which is:

- Written by tutors
- Comprehensive but concise
- In simple English
- Used around the world by Emile Woolf Colleges including China, Russia and the UK

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Syllabus and study guide

Aim

To develop knowledge and skills in the application of management accounting techniques to quantitative and qualitative information, for planning, decision-making, performance evaluation and control.

Main capabilities

After completing this examination paper, students should be able to:

A Explain, apply and evaluate cost accounting techniques

B Select and appropriately apply decision-making techniques to evaluate business choices and promote efficient and effective use of scarce business resources, appreciating the risks and uncertainty inherent in business and resolving those risks

C Apply budgeting techniques and evaluate alternative methods of budgeting, planning and control

D Use standard costing systems to measure and control business performance and to identify remedial action

E Assess the performance of a business from both a financial and non-financial viewpoint, appreciating the problems of controlling divisionalised businesses and the importance of allowing for external aspects.

Rationale

This syllabus builds on the knowledge introduced in the Management Accounting syllabus from the Knowledge module. It also prepares candidates for more specialist capabilities which are covered in the Advanced Performance Management paper.

The syllabus begins by introducing more specialised management accounting topics. There is a little knowledge assumed from the Management Accounting paper – primarily overhead treatments. The objective here is to ensure candidates have a broader background in Management Accounting techniques.

The syllabus then considers decision-making. Candidates need to appreciate the problems surrounding scarce resource, pricing and make or buy decisions and how this relates to the assessment of performance. Risk and uncertainty are a factor of real life decisions, candidates need to understand risk and be able to apply some basic methods to help resolve the risks inherent in decision-making.
Budgeting is an important aspect of many accountants' lives. The syllabus explores different budgeting techniques and the problems inherent in them. The behavioural aspects of budgeting are important for accountants to understand and the syllabus includes consideration of the way individuals react to a budget.

Standard costing and variances are then built on. All the variances examined in the Management Accounting paper are examinable here. The new topics are mix and yield variances and planning and operational variances. Again the link is made to performance management. It is important for accountants to be able to interpret the numbers that they calculate and ask what they mean in the context of performance.

The syllabus concludes with performance measurement and control. This is a major area of the syllabus. Accountants need to understand how a business should be managed and controlled. They should appreciate the importance of both financial and non-financial performance measures in management. They should also appreciate the difficulties in assessing performance in divisionalised businesses and the problems caused by failing to consider external influences on performance. This section leads directly to the Advanced Performance Management syllabus at the higher level.

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5 Throughput accounting

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E Performance measurement and control

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2. Divisional performance and transfer pricing
3. Performance analysis in not-for-profit organisations and the public sector
4. External considerations and behavioural aspects

Approach to examining the syllabus

Paper F5, Performance Management, seeks to examine candidates' understanding of how to manage the performance of a business.

The paper builds on the knowledge acquired in Paper F2, Management Accounting and prepares those candidates who will decide to go on to study Paper P5, Advanced Performance Management at the Professional level

Examination structure

The examination will contain four compulsory, 25 marks questions. There will be calculation and discursive elements to the paper. Generally the paper will seek to draw questions from as many of the syllabus sections as possible.

Study guide

This study guide provides more detailed guidance on the syllabus. You should use this as the basis of your studies.

A Specialist cost and management accounting techniques

1 Activity based costing

(a) Identify appropriate cost drivers under ABC.

(b) Calculate costs per driver and per unit using ABC.

(c) Compare ABC and traditional methods of overhead absorption based on production units, labour hours or machine hours.

(d) Explain the implications of switching to ABC for pricing, sales strategy, performance management and decision-making.

2 Target costing

(a) Derive a target cost in manufacturing and service industries.

(b) Explain the difficulties of using target costing in service industries.

(c) Explain the implications of using target costing on pricing, cost control and performance management.

(d) Suggest how a target cost gap might be closed.

3 Life cycle costing

(a) Identify the costs involved at different stages of the life cycle.

(b) Explain the implications of life cycle costing on pricing, performance management and decision-making.

4 Backflush accounting

(a) Describe the process of backflush accounting and contrast with traditional process accounting.

(b) Explain the implications of backflush accounting on performance management and the control of a manufacturing process.

(c) Identify the benefits of the introduction of backflush accounting.

(d) Evaluate the decision to switch to backflush accounting from traditional process control.

5 Throughput accounting

(a) Calculate and interpret a throughput accounting ratio (TPAR).

(b) Suggest how a TPAR could be improved.

(c) Apply throughput accounting to a multi-product decision-making problem.

B Decision-making techniques

1 Multi-limiting factors and the use of linear programming and shadow pricing

(a) Select an appropriate technique in a scarce resource situation.

(b) Formulate and solve a multiple scarce resource problem both graphically and using simultaneous equations as appropriate.

(c) Explain and calculate shadow prices (dual prices) and discuss their implications on decision-making and performance management.

(d) Calculate slack and explain the implications of the existence of slack for decision-making and performance management.

(Excluding simplex and sensitivity to changes in objective functions)

2 Pricing decisions

(a) Explain the factors that influence the pricing of a product or service.

(b) Explain the price elasticity of demand.

(c) Derive and manipulate a straight line demand equation. Derive an equation for the total cost function (including volume-based discounts).

(d) Evaluate a decision to increase production and sales levels considering incremental costs, incremental revenues and other factors.

(e) Explain different price strategies, including:
  (i) all forms of cost plus
  (ii) skimming
  (iii) penetration
  (iv) complementary product
  (v) product-line
  (vi) volume discounting
  (vii) discrimination
  (viii) relevant cost

(f) Calculate a price from a given strategy using cost plus and relevant cost.

3 Make-or-buy and other short-term decisions

(a) Explain the issues surrounding make vs. buy and outsourcing decisions.

(b) Calculate and compare "make" costs with "buy-in" costs.

(c) Compare in-house costs and outsource costs of completing tasks and consider other issues surrounding this decision.

(d) Apply relevant costing principles in situations involving make or buy in, shut down, one-off contracts and the further processing of joint products.

4 Dealing with risk and uncertainty in decision-making

(a) Suggest research techniques to reduce uncertainty e.g. Focus groups, market research.

(b) Explain the use of simulation, expected values and sensitivity.

(c) Apply expected values and sensitivity to decision-making problems.

(d) Apply the techniques of maximax, maximin, and minimax regret to decision-making problems including the production of profit tables.

(Excluding decision trees and the value of perfect information)

C Budgeting

1 Objectives

(a) Outline the objectives of a budgetary control system.

(b) Explain how corporate and divisional objectives may differ and can be reconciled.

(c) Identify and resolve conflicting objectives and explain implications.

2 Budgetary systems

(a) Explain how budgetary systems fit within the performance hierarchy.

(b) Select and explain appropriate budgetary systems for an organisation (Systems to include: Top down, bottom up, rolling, zero based, activity based, incremental and feed-forward control).

(c) Describe the information used in budget systems and the sources of the information needed.

(d) Explain the difficulties of changing a budgetary system.

(e) Explain how budget systems can deal with uncertainty in the environment.

3 Types of budgets

(a) Indicate the usefulness and problems with different budget types (Zero based, activity based, incremental, master, functional, flexible).

(b) Explain the difficulties of changing the type of budget used.

4 Quantitative analysis in budgeting

(a) Analyse fixed and variable cost elements from total cost data (High Low and regression). Evaluate these methods.

(b) Explain the use of forecasting techniques. (Techniques: Time series, simple average growth models and estimates based on judgement and experience). Predict a future value from provided time series analysis data using both additive and proportional data.

(c) Estimate the learning effect and apply the learning curve to a budgetary problem. This includes calculations on steady states.

(d) Discuss the reservations with the learning curve.

(e) Apply expected values and explain the problems and benefits.

(f) Explain the benefits and dangers inherent in using spreadsheets in budgeting.

5 Behavioural aspects of budgeting

(a) Identify the factors which influence behaviour.

(b) Discuss the issues surrounding setting the difficulty level for a budget.

(c) Explain the benefits and difficulties of the participation of employees in the negotiation of targets.

D Standard costing and variances analysis

1 Budgeting and standard costing

(a) Explain the use of standard costs.

(b) Outline the methods used to derive standard costs and discuss the different types of costs possible.

(c) Explain the importance of flexing budgets in performance management.

(d) Prepare budgets and standards that allow for waste and idle time.

(e) Explain and apply the principle of controllability in the performance management system.

(f) Prepare a flexed budget and comment on its usefulness.

2 Basic variances and operating statements

(a) Calculate, identify the cause of and interpret all basic variances:

(i) Sales price and volume

(ii) Materials total, price and usage

(iii) Labour total, rate and efficiency

(iv) Variable overhead total, expenditure and efficiency

(v) Fixed overhead total, expenditure and, where appropriate, volume, capacity and efficiency.

(b) Explain the effect on labour variances where the learning curve has been used in the budget process.

(c) Produce full operating statements in both a marginal cost and full absorption costing environment, reconciling actual profit to budgeted profit.

(d) Calculate the effect of idle time and waste on variances including where idle time has been budgeted for.

(e) Explain the possible causes of idle time and waste and suggest methods of control.

(f) Calculate, using a simple situation, ABC based variances.

(g) Explain the different methods available for deciding whether or not too investigate a variance cause.

3 Material mix and yield variances

(a) Calculate, identify the cause of and explain mix and yield variances.

(b) Explain the wider issues involved in changing mix e.g. cost, quality and performance measurement issues.

(c) Identify and explain the interrelationship between price, mix and yield.

(d) Suggest and justify alternative methods of controlling production processes.

4 Planning and operational variances

(a) Calculate a revised budget.

(b) Identify and explain those factors that could and could not be allowed to revise an original budget.

(c) Calculate planning and operational variances for sales (including market size and market share), materials and labour.

(d) Explain and resolve the manipulation issues in revising budgets.

5 Behavioural aspects of standard costing

(a) Describe the dysfunctional nature of some variances in the modern environment of JIT and TQM.

(b) Discuss the behavioural problems resulting from using standard costs in rapidly changing environments.

(c) Discuss the effect that variances have on staff motivation and action.

E Performance measurement and control

1 The scope of performance measurement

(a) Describe and calculate and interpret financial performance indicators (FPIs) for profitability, liquidity and risk in both manufacturing and service businesses. Suggest methods to improve these measures.

(b) Describe, calculate and interpret non-financial performance indicators (NFPIs) and suggest method to improve the performance indicated.

(c) Explain the causes and problems created by short-termism and financial manipulation of results and suggest methods encourage a long term view.

(d) Explain and interpret the Balanced Scorecard, and the Building Block model proposed by Fitzgerald and Moon.

(e) Discuss the difficulties of target setting in qualitative areas.

2 Divisional performance and transfer pricing

(a) Explain the basis for setting a transfer price using variable cost, full cost and the principles behind allowing for intermediate markets.

(b) Explain how transfer prices can distort the performance assessment of divisions and decisions made.

(c) Explain the meaning of, and calculate, Return on Investment (ROI) and Residual Income (RI), and discuss their shortcomings.

(d) Compare divisional performance and recognise the problems of doing so.

3 Performance analysis in not for profit organisations and the public sector

(a) Comment on the problems of having non-quantifiable objectives in performance management.

(b) Explain how performance could be measured in these sectors.

(c) Comment on the problems of having multiple objectives in these sectors.

(d) Outline Value for Money (VFM) as a public sector objective.

4 External considerations and behavioural aspects

(a) Explain the need to allow for external considerations in performance management. (External considerations to include stakeholders, market conditions and allowance for competitors).

(b) Suggest ways in which external considerations could be allowed for in performance management.

(c) Interpret performance in the light of external considerations.

(d) Identify and explain the behaviour aspects of performance management *f*

Formulae sheet

Learning curve

$Y = ax^b$

Where y = average cost per batch

a = cost of first batch

x = total number of batches produced

b = learning factor (log LR/log 2)

LR = the learning rate as a decimal

Regression analysis

$y = a + bx$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n}$$

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}}$$

Demand curve

$P = a - bQ$

$$b = \frac{\text{change in price}}{\text{change in quantity}}$$

a = price when $Q = 0$

CHAPTER

1

Activity-based costing

Contents

Traditional costing systems

- Absorption costing
- Brief revision of absorption costing
- Under- and over-absorption
- Criticisms of absorption costing
- Brief revision of marginal costing
- Alternative costing systems

1 Traditional costing systems

1.1 Absorption costing

Absorption costing is a form of costing in which the costs of products are calculated by adding an amount for indirect costs (overheads) to the direct costs of production. Although it is possible to absorb administration, selling and distribution costs into the cost of a product, it has been more usual in practice to restrict absorption costing to production costs.

	$
Direct materials	X
Direct labour	X
Other direct expenses (if any)	X
Direct costs of production	X
Absorbed production overheads	X
Full production cost	X

A full cost can also be calculated for a **service** as well as a product. For example, a telephone company may calculate the full cost per minute of making a telephone call.

1.2 Brief revision of absorption costing

You should be reasonably familiar with absorption costing from your previous studies, but a brief revision is provided here.

- Overheads are indirect costs, which means that the costs (unlike direct costs) cannot be attributed directly to the specific item (product) for which a cost is calculated.
- A 'fair' share of overhead costs is added to the direct costs of the product, using an absorption rate.
- A suitable absorption rate is selected. This is usually a rate per direct labour hour, a rate per machine hour or possibly a rate per unit of product.

- Production overheads may be calculated for the factory as a whole; alternatively, separate absorption rates may be calculated for each different production department. (In the F5 exam, it is much more likely that a question involving absorption costing will give a factory-wide absorption rate rather than separate departmental absorption rates.)
- The overhead absorption rate (or rates) is determined in advance for the financial year. It is calculated in one of the following ways:

$$\frac{\text{Budgeted production overhead expenditure}}{\text{Budgeted activity}} \quad \text{OR} \quad \frac{\text{Budgeted production overhead expenditure}}{\text{Normal annual level of activity}}$$

The 'activity' is the number of labour hours in the year, the number of machine hours or the number of units produced, depending on the basis of absorption (labour hour rate, machine hour rate or rate per unit) that is selected.

Although an exam question is likely to assume that the absorption rate is obtained from the budgeted level of activity, the normal level of activity might be used instead in a question. The normal level of activity is the average annual level of production activity.

Example

A manufacturing company makes two products, X and Y. Budget information about these products is as follows.

	Product X	**Product Y**
Direct cost per unit	\$10	\$7
Direct labour time to make each unit	15 minutes	20 minutes
Budgeted production for the year	8,000 units	9,000 units

The budgeted production overheads for the year are \$120,000. The company uses an absorption costing system and a direct labour hour absorption rate.

What is the absorption rate for overheads and what is the budgeted cost per unit of X and unit of Y?

Answer

	Hours
Budgeted labour hours: Product X: 8,000 × 15/60	2,000
Budgeted labour hours: Product Y: 9,000 × 20/60	3,000
Total budgeted hours for the year	5,000
Budgeted production overheads	\$120,000
Absorption rate per direct labour hour	\$24

	Product X		Product Y
	$ per unit		$ per unit
Direct cost	10		7
Production overheads: $24 × 15/60	6	$24 × 20/60	8
Full production cost	16		15

1.3 Under- and over-absorption

The overhead absorption rate is decided in advance, before the beginning of the financial year. Overheads are added to product costs at this predetermined rate, even though actual overhead expenditure and the actual volume of production might differ from the estimates used in the budget to work out the absorption rate.

As a consequence, the amount of overheads added to the cost of products manufactured is likely to be different from actual overhead expenditure in the period. The difference is under- or over-absorbed overheads.

	$
Overheads absorbed into production costs using the absorption rate	X
Actual overhead expenditure	X
Under- or over-absorbed overheads	(X) or X

Overheads are under-absorbed when the amount of overheads absorbed into production costs is less than the actual amount of overhead expenditure.

Overheads are over-absorbed when the amount of overheads absorbed into production costs is more than the actual amount of overhead expenditure.

The amount of under- or over-absorbed overheads is written to profit or loss for the year as an adjusting figure. If there are under-absorbed overhead the profit is adjusted down (because production costs have been under-stated); and if there are over-absorbed overheads the profit is adjusted upwards.

Example

A manufacturing company has a system of absorption costing and the overhead absorption rate for the year just ended was $24 per direct labour hour. This rate was based on budgeted overhead expenditure for the year of $120,000 and 5,000 budgeted direct labour hours.

Actual production during the year amounted to 5,400 direct labour hours and actual production overhead expenditure was $148,000.

What was the under- or over-absorbed overhead for the year? Can the reasons for this under- or over-absorption be explained?

a

Answer

	$
Overheads absorbed into production costs: 5,400 hours × $24 per hour	129,600
Actual overhead expenditure	148,000
Under- absorbed overheads	(18,400)

The under-absorption of overheads can be explained by a combination of two factors.

- Actual overhead expenditure was different from the budgeted expenditure on which the absorption rate was based. There is an 'expenditure variance'.
- Actual volume of activity was different from the budgeted volume of activity on which the absorption rate was based. There is an 'volume variance'.

	$
Budgeted overhead expenditure	120,000
Actual overhead expenditure	148,000
Expenditure variance – adverse, since spending more than budgeted	(28,000)

	hours
Budgeted production volume (labour hours)	5,000
Actual production volume (labour hours)	5,400
Volume variance in direct labour hours (favourable)	400

Absorption rate per direct labour hour	$24
Volume variance in $ (favourable)	$9,600

The volume variance is favourable because actual production volume was more than the budgeted volume, and as a consequence there should have been some over-absorption.

Summary	$
Expenditure variance	(28,000)
Volume variance	9,600
Under- absorbed overheads	(18,400)

1.4 Criticisms of absorption costing

Traditional absorption costing is still in use with some companies.

- Its main advantage is that it provides a rational method of charging overhead costs to production costs, so that a full cost of production can be calculated for closing inventories.

- It may also be argued that absorption costing is useful for some pricing decisions. Pricing is the subject of a later chapter.

However traditional absorption costing has many weaknesses, especially in a 'modern' manufacturing environment.

- Production overhead costs are often high relative to direct production costs. A system of adding overhead costs to product costs by using time spent in production (direct labour hours or machine hours) is therefore difficult to justify.
- A full cost of production has only restricted value as management information. Managers use accounting information to help them make decisions for the future, but most of the information they need cannot be provided by traditional absorption costing methods.

Marginal costing has been suggested as an alternative to absorption costing, because it can provide more useful management information.

1.5 Brief revision of marginal costing

You should be reasonably familiar with marginal costing from your previous studies, but a brief revision is provided here.

- The key element in marginal costing is the distinction between fixed costs and variable costs. Fixed cost expenditure during any period of time is the same amount in total regardless of the volume of activity (the volume of production and sales) whereas variable costs rise or fall in direct proportion to increases or falls in the activity level.
- It is normally assumed that direct costs of production are also variable costs. This is usually 'true' for direct materials. However, direct labour costs might be treated as a variable cost in marginal costing even when direct labour employees are paid a fixed wage or salary and so are actually a fixed cost.
- A distinction could be made between variable and fixed overheads, so that some overhead costs are recognised as a variable cost and included in the marginal cost of production or sales. Marginal cost is therefore direct cost plus variable overhead cost.
- Inventory of finished goods and work-in-progress is valued at marginal (variable) production cost, not at full absorbed production cost.
- Profit is measured as follows:

	$
Sales revenue	X
Variable cost of sales	(X)
Total contribution	X
Fixed cost expenditure	(X)
Profit or loss	X or (X)

Fixed costs are therefore given less emphasis or attention in marginal costing than variable costs and contribution.

Marginal costing is used for some aspects of planning or decision-making. For example cost-volume-profit analysis (CVP analysis) can be used to calculate the breakeven point for sales (where total contribution equals total fixed costs, and there is neither profit nor loss).
Similarly, CVP analysis can be used to calculate the volume of sales required to achieve a target figure for profit.

Weaknesses of marginal costing

Marginal costing is more useful than absorption costing as a technique for providing some information to management for the purpose of planning or short-term decision making. For example it is used with decision-making techniques such as breakeven analysis and linear programming, which is the subject of a later chapter.

However, marginal costing does not help management with the monitoring and controlling of fixed costs. As production systems have become more automated, the proportion of fixed costs in the total costs of production has risen, and the proportion of direct costs (particularly direct labour costs) has fallen.

Another problem with marginal costing is the valuation of closing inventory. Companies are required by international financial reporting standards (or by local GAAP) to include some production overhead costs in inventory valuation. This means that if a manufacturing company uses a system of marginal costing, it also needs an additional system for adding overhead costs to inventory values for the purpose of financial reporting.

1.6 Alternative costing systems

Both traditional absorption costing and marginal costing have weaknesses as a costing system for manufacturing companies, and neither of these costing systems is well-suited to costing in a modern manufacturing environment.

A number of alternative costing methods have been developed with a view to replacing the traditional methods. These include activity based costing, backflush accounting and throughput accounting.

Activity based costing (ABC)

2 Activity based costing (ABC)

2.1 Introduction to activity based costing

Activity based costing (ABC) is a form of absorption costing. However, it differs from traditional absorption costing, because it takes a different approach to the apportionment and absorption of production overhead costs.

Activity-based costing is based on the following assumptions:

- In a modern manufacturing environment, a large proportion of total costs are overhead costs, and direct labour costs are relatively small.
- Because overhead costs are large, it is appropriate to trace these costs as accurately as possible to the products that create the cost.
- In traditional absorption costing, production overheads are allocated or apportioned to production departments, and are then absorbed on the basis of the volume of production work, using a rate per direct labour hour or rate per machine hour.
- However many production overhead costs are not directly related to the production work that is carried out. For example:
  - The costs of quality control and inspection depend on the quality standards and inspection methods that are used: these do not necessarily relate to the number of hours worked in production.
  - The costs of processing and chasing customer orders through the factory relate more to the volume of customer orders rather than the hours worked on each job in production.
  - Costs of managing the raw materials inventories (storage costs) relate more to the volume of materials handled rather than hours worked on the material in production.
  - The costs of production planning relate more to the volume and complexity of customer orders or the number of batch production runs, rather than hours worked in production.

- The traditional methods of absorbing production overhead costs on the basis of direct labour hours or machine hours do not have any rational justification and a better method is needed for charging overheads to different products or jobs.

2.2 Activities

Activity based costing (ABC) takes the view that many production overhead costs can be associated with particular activities that are not direct production work.

It is therefore appropriate to identify these activities and allocate overhead costs to them. Overhead costs can then be added to product costs by using a separate absorption rate for each activity. The costing of overheads and full production costs is therefore based on activities, rather than hours worked in production.

Identifying activities

A problem with introducing activity-based costing is deciding which activities create or 'drive' overhead costs.

They should be activities that use up a large amount of resources, such as labour time. However, there are many different activities within a manufacturing company, and it is not always clear which activities should be used for costing.

Activities might include, for example:

- Materials handling and storage
- Customer order processing and chasing
- Materials purchasing
- Quality control and inspection
- Production planning
- Repairs and maintenance.

These activities are not necessarily confined to single functional departments within the production department.

Although ABC is often concerned with production costs, it can also be applied to activities outside production, such as sales and distribution. Sales and distribution activities might include:

- selling activities
- warehousing and despatch
- after-sales service.

In a system of activity-based costing, it is preferable to select a fairly small number of activities. If a large number of activities are selected, the costing system could become too complex and time-consuming to operate.

The activities are selected on the basis of management judgement and experience, and their knowledge of the activities within manufacturing.

If only a small number of activities are identified and selected for use in the ABC system, it is likely that some overhead costs will not relate to those activities. An example might be the costs of rental of a factory and the running costs of the factory (heating and lighting costs, security costs and so on). These overhead costs not related to the selected activities might therefore be recorded as 'general overheads' and absorbed into product costs separately.

2.3 Cost drivers and cost pools

Cost drivers

For each activity, there should be a cost driver. (An activity might have more than one cost driver, but if an activity does have more than one cost driver the costing system becomes more complex. Just one cost driver per activity is desirable.)

A cost driver for an activity can be defined as a factor that determines the cost of the activity. It is something that will cause the costs for an activity to increase as more of the activity is performed.

It is not always obvious what the cost driver for an activity might be. A cost driver might be unique to the activity. Here are some examples.

Activity	Possible cost driver
Materials handling and storage	Raw materials: purchases of materials
	Finished goods: volume of products made
Customer order processing	Number of customer orders
Materials purchasing	Number of purchase orders
Quality control and inspection	Number of inspections
Production planning	Number of production runs or batches
Repairs and maintenance	Number of machines, or machine hours operated
Selling	Number of sales orders
Warehousing and despatch	Number of deliveries made

Each cost driver must be a factor that can be measured, so that the number of units of the cost driver that have occurred during each period can be established.

Activity	Possible cost driver and measure of activity level
Materials handling and storage	Raw materials: purchases of materials
	Finished goods: volume of products made
Customer order processing	Number of customer orders

Activity	Possible cost driver and measure of activity level
Materials purchasing	Number of purchase orders
Quality control and inspection	Number of inspections
Production planning	Number of production runs or batches
Repairs and maintenance	Number of machines, or machine hours operated
Selling	Number of sales orders
Warehousing and despatch	Number of deliveries made

Overhead costs are therefore caused by activities, and the costs of activities are driven by factors other than production volume.

In addition, it must be possible to relate the cost drivers for each activity to the products or services that the entity sells. For example:

Activity	Possible cost driver	Information needed for ABC
Customer order processing	Number of customer orders	Number of orders for each product
Materials purchasing	Number of purchase orders	Number of orders for materials for each finished product
Quality control and inspection	Number of inspections	Number of inspections of output of each product
Production planning	Number of production runs or batches	Number of runs or batches of each product
Repairs and maintenance	Number of machines, or machine hours operated	Number of machines or machine hours worked for each product
Selling	Number of sales orders	Number of orders for each product
Warehousing and despatch	Number of deliveries made	Number of deliveries for each product

Cost pools

Overhead costs are allocated (or allocated and apportioned) to each activity, and for each activity there is a 'cost pool'. A cost pool is simply the overhead expenditure allocated and apportioned to an activity.

In ABC, overheads are absorbed into the cost of products (or services) at a separate rate for each cost pool (each activity). The total production cost for each product or service is therefore direct production costs plus absorbed overheads for each activity. In addition, as mentioned earlier, there might also be an absorbed amount for general overheads, which cannot be attributed to any specific activity and cost pool.

Example

A manufacturing company has identified that a large part of its overhead costs are incurred in handling customer orders, and that the same effort goes into handling a small order as the effort required to deal with a large order. Order sizes differ substantially. The company makes four products, and the estimated costs of order handling are $250,000 per year.

The company uses ABC, and wants to establish an order-handling overhead cost for each product, based on the following budget:

Product	Number of orders	Total number of units ordered
W	15	60,000
X	22	33,000
Y	4	40,000
Z	9	27,000
	50	160,000

If the cost driver for order handling is the number of orders handled, the budgeted order handling cost will be $250,000/50 = $5,000 per order. Overhead costs will be charged to products as follows:

Product	Number of orders	Cost
		$
W	15	75,000
X	22	110,000
Y	4	20,000
Z	9	45,000
	50	250,000

Example

Menia Co makes three products, X, Y and Z using the same direct labour employees and the same machine for production. The company uses activity-based costing.

Production details for the three products for a typical period are as follows:

	Hours per unit		Materials	Production
	Labour hours	Machine hours	Cost per unit	units
			$	
Product X	0.25	0.75	10.0	1,500
Product Y	0.75	0.50	6.0	2,500
Product Z	0.50	1.50	12.5	14,000

Direct labour costs $16 per hour and production overheads are absorbed on a machine hour basis.

Total production overheads are $1,309,000 and further analysis shows that the total production overheads can be divided as follows:

	%
Costs relating to machinery	15
Costs relating to inspection	35
Costs relating to set-ups	30
Costs relating to materials handling	20
Total production overhead	100

The following total activity volumes are associated with each product for the period:

	Number of inspections	Number of set-ups	Number of movements of materials
Product X	360	80	40
Product Y	80	120	80
Product Z	960	500	280
	1,400	700	400

Required:

Calculate the cost per unit for each product using ABC principles.

Answer

Working: Machine hours per period = (1,500 × 0.75) + (2,500 × 0.5) + (14,000 × 1.5) 1,125 + 1,250 + 21,000 = 23,375 hours.

Activity	Cost allocated	Cost driver	Activity per period	Overhead absorption rate
	$			
Machinery operations (15%)	196,350	Machine hrs	23,375	$8.40 per machine hour
Inspection (35%)	458,150	Inspections	1,400	$327.25 per inspection
Set-ups (30%)	392,700	Set-ups	700	$561 per set-up
Materials handling (20%)	261,800	Movements	400	$654.50 per movement
Total	1,309,000			

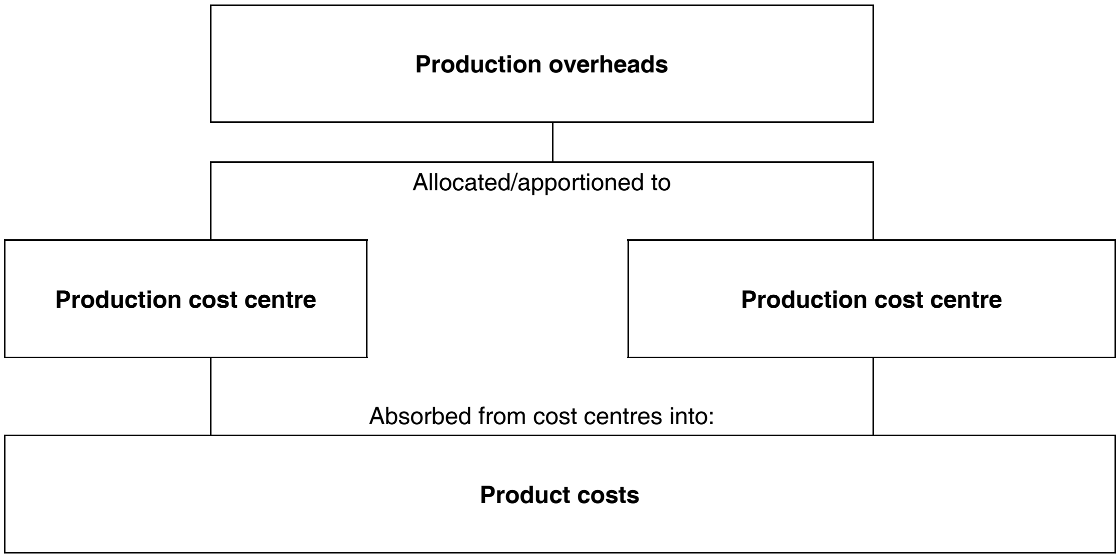
Overheads per cost pool and per unit	**X**	**Y**	**Z**
Production overheads:	$	$	$
Machinery at $8.40 per machine hour	9,450	10,500	176,400
Inspection at $327.25 per inspection	117,810	26,180	314,160
Set-ups at $561 per set-up	44,880	67,320	280,500
Materials handling at $654.50 per movement	26,180	52,360	183,260
Overhead costs per product	198,320	156,360	954,320
Number of units	1,500	2,500	14,000
Overhead cost per unit	$132.21	$62.54	$68.17

Production cost per unit: ABC	**X**	**Y**	**Z**
	$	$	$
Direct materials	10.00	6.00	12.50
Direct labour	4.00	12.00	8.00
Production overhead	132.21	62.54	68.17
Full production cost per unit	146.21	80.54	88.67

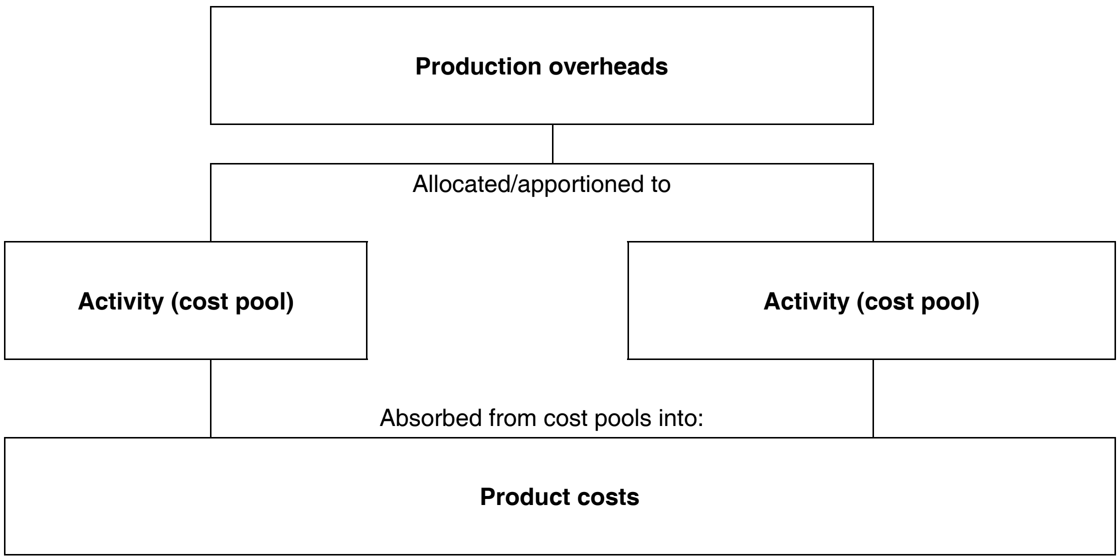
2.4 ABC and traditional absorption costing

The difference between traditional absorption costing and ABC is shown by the following diagrams:

Traditional absorption costing



Activity-based costing



Although ABC is a form of absorption costing, the effect of ABC could be to allocate overheads in a completely different way between products. Product costs and product profitability will therefore be very different with ABC compared with traditional absorption costing.

Example

Entity Blue makes and sells two products, X and Y. Data for production and sales each month are as follows:

	Product X	Product Y
Sales demand	4,000 units	8,000 units
Direct material cost/unit	$20	$10
Direct labour hours/unit	0.1 hour	0.2 hours
Direct labour cost/unit	$2	$4

Production overheads are $500,000 each month. These are absorbed on a direct labour hour basis.
An analysis of overhead costs suggests that there are four main activities that cause overhead expenditure.

Activity	Total cost	Cost driver	Total number	Product X	Product Y
	$				
Batch setup	100,000	Number of set-ups	20	10	10
Order handling	200,000	Number of orders	40	24	16
Machining	120,000	Machine hours	15,000	6,000	9,000
Quality control	80,000	Number of checks	32	18	14
	500,000				

Required

Calculate the full production costs for Product X and Product Y, using:

(a) traditional absorption costing

(b) activity based costing.

Answer

Traditional absorption costing
The overhead absorption rate = $500,000/ (4,000 × 0.1 + 8,000 × 0.2) = $250

	Product X	Product Y	Total
	$	$	
Direct materials	20	10	
Direct labour	2	4	
Overhead (at $250 per hour)	25	50	
Cost per unit	47	64	
Number of units	4,000	8,000	
Total cost	$188,000	$512,000	$700,000

Activity based costing

Activity	Total cost	Cost driver		Product X	Product Y
	$		$	$	$
Batch setup	100,000	Cost/setup	5,000	50,000	50,000
Order handling	200,000	Cost/order	5,000	120,000	80,000
Machining	120,000	Cost/machine hour	8	48,000	72,000
Quality control	80,000	Cost/check	2,500	45,000	35,000
	500,000			263,000	237,000

	Product X	Product Y	Total
	$	$	$
Direct materials	80,000	80,000	
Direct labour	8,000	32,000	
Overheads	263,000	237,000	
Total cost	351,000	349,000	$700,000
Number of units	4,000	8,000	
Cost per unit	$87.75	$43.625	

Using ABC in this situation, the cost per unit of Product X is much higher than with traditional absorption costing and for Product Y the unit cost is much less.

The difference is caused by the fact that Product X use only 20% of total direct labour hours worked, but much larger proportions of set-up resources, order handling resources, machining time and quality control resources. As a result, the overheads charged to each product are substantially different.

This is an important feature of activity-based costing. The overheads charged to products, and so the overhead cost per unit of product, can be significantly different from the overhead cost per unit that would be obtained from traditional absorption costing.

2.5 When using ABC might be appropriate

Activity based costing could be suitable as a method of costing in the following circumstances:

- In a manufacturing environment, where absorption costing is required for inventory valuations.
- Where a large proportion of production costs are overhead costs, and direct labour costs are relatively small.
- Where products are complex.

- Where products are provided to customer specifications.
- Where order sizes differ substantially, and order handling and despatch activity costs are significant.

2.6 Advantages and disadvantages of ABC

Advantages

- ABC provides useful information about the activities that drive overhead costs. Traditional absorption costing and marginal costing do not do this.
- ABC therefore provides information that could be relevant to long-term cost control and long-term product selection or product pricing.
- ABC can provide the basis for a management information system to manage and control overhead costs.
- With ABC, overheads are charged to products on the basis of the activities that are required to provide the product: Each product should therefore be charged with a 'fair share' of overhead cost that represents the activities that go into making and selling it.
- It might be argued that full product costs obtained with ABC are more 'realistic', although it can also be argued that full product cost information is actually of little practical use or meaning for management.
- There is also an argument that in the long run, all overhead costs are variable (even though they are fixed in the short-term). Measuring costs with ABC might therefore provide management with useful information for controlling activities and long-term costs.

Disadvantages

- The analysis of costs in an ABC system may be based on unreliable data and weak assumptions. In particular, ABC systems may be based on inappropriate activities and cost pools, and incorrect assumptions about cost drivers.
- ABC provides an analysis of historical costs. Decision-making by management should be based on expectations of future cash flows. It is incorrect to assume that there is a causal relationship between a cost diver and an activity cost, so that increasing or reducing the activity will result in higher or lower activity costs.
- In some cases, ABC may be little more than a sophisticated absorption costing system.
- Within ABC systems, there is still a large amount of overhead cost apportionment. General overhead costs such as rental costs, insurance costs and heating and lighting costs may be apportioned between cost pools. This reduces the causal link between the cost driver and the activity cost.
- Many ABC systems are based on just a small number of cost pools and cost drivers. More complex systems are difficult to justify, on grounds of cost.
- Many activities and cost pools have more than one cost driver. Identifying the most suitable cost driver for a cost pool/activity is often difficult.

- Traditional cost accounting systems may be more appropriate for the purpose of inventory valuation and financial reporting.
- It might be a costly system to design and use. The costs might not justify the benefits. It must be remembered that full product costing is of little relevance for management decision-making.

2.7 Implications of switching to ABC

The cost information produced using ABC can be used to improve:

- pricing decisions
- sales strategy
- performance measurement
- decision-making

Companies may use various methods to decide the selling prices for their products, but in the long run whatever method of pricing is used, the sales price must exceed the average total cost per unit sold in order to make a profit.

Traditional absorption costing often leads to too much overhead allocated to high volume standardised products and too little overhead being allocated to low volume, complex products. Standard products might therefore seem much less profitable than low-volume complex products. ABC costs may reflect more accurately the resources used and so the costs incurred to make a product and therefore provide better information for managers when deciding on sales prices and the product and sales mix.

Activity based costing may be used to analyse costs of product lines, customer groups and distribution outlets to more accurately assess profitability and determine where management attention should be focused. Sales strategy may be to improve the profitability of low margin products and customers, increase marketing to high margin products and customers with the intention of increasing market share or even to change the mix of products or distribution outlets.

ABC information may improve understanding of how costs are incurred in overhead departments. It is difficult to control overhead costs in an absorption costing system as often responsibility is not assigned to specific managers. By understanding the activities which drive costs, responsibility for monitoring key performance indicators can be assigned to specific managers and action can be taken if performance is not as expected.

The benefits of using ABC information for decision-making are mainly due to the improved accuracy of cost information and better understanding of the activities which drive costs. However, short-run decision-making is based on relevant costs, that is, future cash flows which change as a result of the decision, and many commentators argue that marginal costing is more suitable for this purpose. ABC might be helpful for controlling longer-term overhead costs, but not for controlling overhead costs in the short term.

2.8 Problems with switching to activity-based costing

There can be major practical difficulties in switching from a system of traditional absorption costing to a system of ABC.

- Management have to understand ABC and how it differs from the costing system that has been used in the past. This will require training.
- It might be difficult to identify the activities that drive most overhead costs.
- Even if activities are successfully identified, it might be difficult to identify the most suitable cost driver for that activity.
- The costing system will have to be changed so that overheads are allocated and apportioned to cost pools. This will require administrative effort.
- There is often resistance amongst employees to change. Managers and other employees might not trust the information about costs that ABC provides.

2.9 Activity-based costing and costs of services

Activity-based costing was developed initially as a method of costing in a manufacturing environment. However, ABC can also be applied to service industries and the costing of services provided to customers. The same basic principles apply to service costing with ABC as to product costing with ABC.

CHAPTER 2

Other costing systems

Contents

Target costing

- Origins of target costing
- The purpose of target costing
- The target costing method
- Elements in the estimated cost and target cost
- Closing the target cost gap
- Advantages of target costing
- The implications of using target costing
- Target costing and services

1 Target costing

1.1 Origins of target costing

Target costing originated in Japan in the 1970s. It began with recognition that customers were demanding more diversity in products that they bought, and the life cycles of products were getting shorter. This meant that new products had to be designed more frequently to meet customer demands.

Companies then became aware that a large proportion of the costs of making a product are committed at the design stage, before the product goes into manufacture. The design stage was therefore critical for ensuring that new products could be manufactured at a cost that would enable the product to make a profit for the company.

1.2 The purpose of target costing

Target costing is a method of strategic management of costs and profits. As its name suggests, target costing involves setting a target or objective for the maximum cost of a product or service, and then working out how to achieve this target.

It is used for business strategy in general and marketing strategy in particular, by companies that operate in a competitive market where new products are continually being introduced to the market. In order to compete successfully, companies need to be able to:

- continually improve their existing products or design new ones
- sell their products at a competitive price; this might be the same price that competitors are charging or a lower price than competitors, and
- make a profit.

In order to make a profit, companies need to make the product at a cost below the expected sales price.

Target costing and new product development

Target costing is used mainly for new product development. This is because whenever a new product is designed and developed for a competitive market, a company needs to know what the maximum cost of the new product must be so that it will sell at a profit.

A company might decide the price that it would like to charge for a new product under development, in order to win a target share of the market. The company then decides on the level of profitability that it wants to achieve for the product, in order to make the required return on investment. Having identified a target price and a target profit, the company then establishes a target cost for the product. This is the cost at which the product must be manufactured and sold in order to achieve the target profits and return at the strategic market price.

Keeping the costs of the product within the target level is then a major factor in controlling its design and development.

New product design and development	$
Decide: The target sales price	X
Deduct: The target profit margin	(X)
Equals: The target cost (maximum cost in order to meet or exceed the target profit)	X

The reason that target costing is used for new products, as suggested earlier, is that the opportunities for cutting costs to meet a target cost are much greater during the product design stage than after the product development has been completed and the production process has been set up.

- Typically, when a new product is designed, the first consideration is to design a product that will meet the needs of customers better than rival products. However, this initial product design might result in a product with a cost that is too high, and which will therefore not be profitable.
- The estimated cost of a product design can be compared with the target cost. If the expected cost is higher than the target cost, there is a cost 'gap'.
- A cost gap must be closed by finding ways of making the product more cheaply without losing any of the features that should make it attractive to customers and give it 'value'. For example, it might be possible to simplify that product design or the production process without losing any important feature of the product. It might also be possible to re-design the product using a different and cheaper material, without loss of 'value'.
- Having worked out how to reduce costs at the product design stage, management should try to ensure that the product is developed and the method of producing it is introduced according to plan, so that the target cost is achieved.

1.3 The target costing method

The principles of target costing may therefore be summarised as follows.

Target costing is based on the idea that when a new product is developed, a company will have a reasonable idea about:

- the price at which it will be able to sell the product, and
- the sales volumes that it will be able to achieve for the product over its expected life.

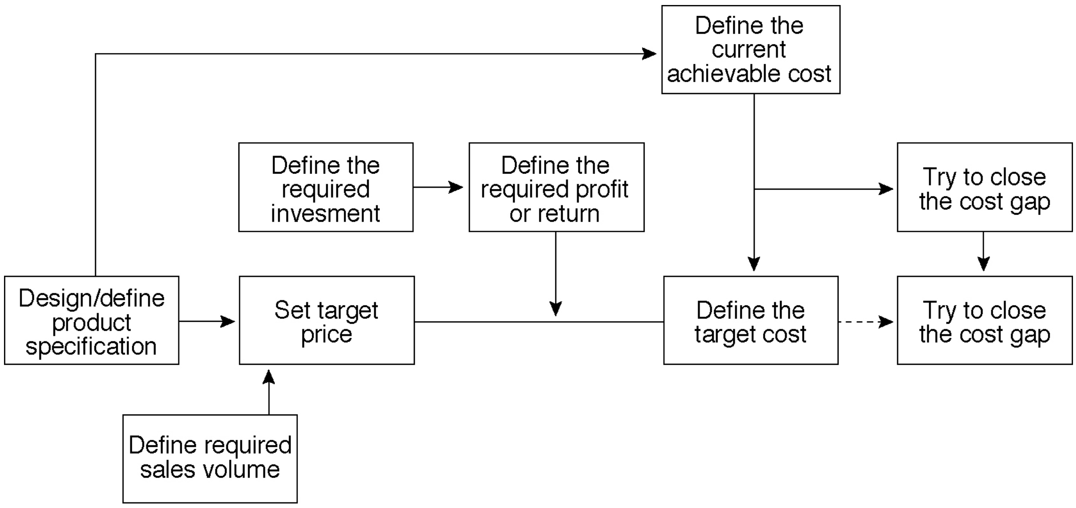
There may also be estimates of the capital investment required, and any incremental fixed costs (such as marketing costs or costs of additional salaried staff).

Taking estimates of sales volumes, capital investment requirements and incremental fixed costs over the life cycle of the product, it should be possible to calculate a target cost.

- The target cost for the product might be the maximum cost for the product that will provide at least the minimum required return on investment.
- However, an examination question might expect you to calculate the target cost from a target selling price and a target profit margin.

The elements in the target costing process are shown in the diagram below.

Target costing



1.4 Elements in the estimated cost and target cost

A problem with target costing is to make sure that the estimates of cost are realistic. It is difficult to measure the cost of a product that has not yet been created, and the cost must include items such as raw material wastage rates and direct labour idle time, if these might be expected to occur in practice.

Raw materials costs

The target cost should allow for expected wastage rates or loss in processing. The price of materials should also allow for any possible increases up to the time when the new product development has been completed. Estimating prices of materials can be difficult when prices are volatile – such as commodity prices, which can be subject to large increases and falls within relatively short periods of time.

Direct labour

The target cost should allow for any expected idle time that will occur during the manufacture of the product. This might be the normal level of idle time in the company's manufacturing operations.

Production overheads

A target cost could be a target marginal cost. However production overhead costs are often a large proportion of total manufacturing costs, and it is therefore more likely that the target cost will be a full cost, including production overheads. If activity-based costing is used, it might be possible to identify opportunities for limiting the amount of production overheads absorbed into the product cost by designing the product in a way that limits the use of activities that drive costs, for example by reducing the need for materials movements or quality inspections.

e

Example

A company has designed a new product. NP8. It currently estimates that in the current market, the product could be sold for $70 per unit. A gross profit margin of at least 30% on the selling price would be required, to cover administration and marketing overheads and to make an acceptable level of profit.

A cost estimation study has produced the following estimate of production cost for NP8.

Cost item	
Direct material M1	$9 per unit
Direct material M2	Each unit of product NP8 will require three metres of material M2, but there will be loss in production of 10% of the material used. Material M2 costs $1.80 per metre.
Direct labour	Each unit of product NP8 will require 0.50 hours of direct labour time. However it is expected that there will be unavoidable idle time equal to 5% of the total labour time paid for. Labour is paid $19 per hour.
Production overheads	It is expected that production overheads wil lbe absorbed into product costs at the rate of $60 per direct labour hour, for each active hour worked. (Overheads are not absorbed into the cost of idle time.)

Required
Calculate:

(a) the expected cost of Product NP8

(b) the target cost for NP8

(c) the size of the cost gap.

a

Answer

Expected cost per unit	$	$
Direct material M1		9.0
Direct material M2: 3 metres × 100/90 × $1.80		6.0
Direct labour: 0.5 hours × 100/95 × $19		10.0
Production overheads: 0.5 hours × $60		30.0
Expected full cost per unit		55.0
Target cost		
Sales price	70.0	
Minimum gross profit margin (30%)	21.0	
Target cost		49.0
Cost gap		6.0

The company needs to identify ways of closing this cost gap.

1.5 Closing the target cost gap

Target costs are rarely achievable immediately and ways must be found to reduce costs and close the cost gap.

Target costing should involve a multi-disciplinary approach to resolving the problem of how to close the cost gap. The management accountant should be involved in measuring estimated costs. Ways of reducing costs might be in product design and engineering, manufacturing processes used, selling methods and raw materials purchasing. Ideas for reducing costs can therefore come from the sales, manufacturing, engineering or purchasing departments.

Common methods of closing the target cost gap are:

- To re-design products to make use of common processes and components that are already used in the manufacture of other products by the company.
- To discuss with key suppliers methods of reducing materials costs. Target costing involves the entire 'value chain' from original suppliers of raw materials to the customer for the end-product, and negotiations and collaborations with suppliers might be an appropriate method of finding important reductions in cost.
- To eliminate non value-added activities or non-value added features of the product design. Something is 'non-value added' if it fails to add anything of value for the customer. The cost of non-value added product features or activities can therefore be saved without any loss of value for the customer. Value analysis may be used to systematically examine all aspects of a product cost to provide the product at the required quality at the lowest possible cost.
- To train staff in more efficient techniques and working methods. Improvements in efficiency will reduce costs.

- To achieve economies of scale. Producing in larger quantities will reduce unit costs because fixed overhead costs will be spread over a larger quantity of products. However, production in larger quantities is of no benefit unless sales demand can be increased by the same amount.
- To achieve cost reductions as a result of the learning curve or, more likely, the experience curve effect. The learning curve is described in a later chapter and is most likely to exist in a labour intensive environment. It results in cost savings as labour becomes more familiar with performing a new and complex task. The experience curve effect relates to cost savings made in costs other than labour costs as the company becomes more familiar with production of a new product. For example, management of the process and marketing may become more efficient as the company gains experience of making and selling the product.

1.6 Advantages of target costing

There are several possible advantages from the use of target costing.

- It helps to improve the understanding within a company of product costs.
- It recognises that the most effective way of reducing costs is to plan and control costs from the product design stage onwards.
- It helps to create a focus on the final customer for the product or service, because the concept of 'value' is important: target costs should be achieved without loss of value for the customer.
- It is a multi-disciplinary approach, and considers the entire supply chain. It could therefore help to promote co-operation, both between departments within a company and also between a company and its suppliers and customers.
- Target costing can be used together with recognised methods for reducing costs, such as value analysis, value engineering, just in time purchasing and production, Total Quality Management and continuous improvement.

1.7 The implications of using target costing

The use of a target costing system has implications for pricing, cost control and performance measurement.

Target costing can be used with pricing policy for a company's products or services. A company might decide on a target selling price for either a new or an existing product, which it considers necessary in order to win market share or achieve a target volume of sales. Having identified the selling price that it wants for the product, the company can then work out a target cost.

Cost control and performance measurement has a different emphasis when target costing is used.

- Cost savings are actively sought and made continuously over the life of the product
- There is joint responsibility for achieving benchmark savings. If one department fails to deliver the cost savings expected, other departments may find ways to achieve the savings

- Staff are trained and empowered to find new ways to reduce costs while maintaining the required quality.

Target costing is more likely to succeed in a company where a culture of 'continuous improvement' exists.

1.8 Target costing and services

Target costing can be used for services as well as products. Services vary widely in nature, and it is impossible to make general statements that apply to all types of services. However, features of some service industries that make them different from manufacturing are as follows.

- Some service industries are labour-intensive, and direct materials costs are only a small part of total cost. Opportunities for achieving reductions in materials costs may therefore be small.
- Overhead costs in many services are very high. Effective target costing will therefore require a focus on how to reduce overhead costs.

A service company might deliver a number of different services through the same delivery system, using the same employees and the same assets. Introducing new services or amendments to existing services therefore means adding to the work burden of employees and the diversity or complexity of the work they do.

- A system of target costing therefore needs to focus on quality of service and value for the customer. Introducing a new service might involve a loss of value in the delivery of existing services to customers. For example, adding a new service to a telephone call centre could result in longer waiting times for callers.
- New services might be introduced without proper consideration being given to whether the service is actually profitable. For example, a restaurant might add additional items to its menu, in the belief that the only additional cost is the cost of the food. In practice there would be implications for the purchasing and preparation of the food and possibly also for the delivery of food from the kitchen to the restaurant dining area. New items added to the menu might therefore make losses unless all aspects of cost are properly considered.
- When a single delivery system is used for services, the cost of services will consist largely of allocated and apportioned overheads. For target costing to be successful, there must be a consistent and 'fair' method of attributing overhead costs to services (both existing services and new services).
- Services might be provided by not-for-profit entities. For example, health services might be provided free of charge by the government. When services are provided free of charge, target costing can be used for new services. However, it is doubtful whether concepts of 'target price' and 'target profit' can be used by a not-for-profit entity. This raises questions about how to decide what the target cost should be.

Product life cycle costing

- The nature of life cycle costing
- A product life cycle
- Research and development phase
- Introduction phase
- Growth phase
- Maturity phase
- Decline phase
- The implications of using life cycle costing

2 Product life cycle costing

2.1 The nature of life cycle costing

Life cycle costing is sometimes called 'whole life costing' or 'whole life cycle costing'. As these terms suggest, it is a costing method that considers the costs of a product or an asset over its entire marketable or useful life.

Life cycle costing can be applied to:

- Products that are introduced to the market and then manufactured and sold over a number of years until they are eventually withdrawn from the market
- Buildings and other major construction items, whose costs change over their useful life from construction to eventual demolition.

Life cycle costs

The costs of a product or asset over its life cycle could be divided into three categories:

- **Acquisition costs, set-up costs or market entry costs**. These are costs incurred initially to bring the product into production and to start selling it, or the costs incurred to complete the construction of a building or other major construction asset
- **Operational costs or running costs** throughout the life of the product or asset
- **End-of-life costs**. These are the costs incurred to withdraw a product from the market or to demolish the asset at the end of its life.

Acquisition costs or set-up costs are usually 'one-off' capital expenditures and other once-only costs, such as the costs of training staff and establishing systems of documentation and performance reporting. Similarly, end-of-life costs are 'one-off' items that occur just once.

Running costs or operational costs are regular and recurring annual costs throughout the life of the product or asset. However, these may vary over time: for example maintenance costs for an item of equipment, such as the maintenance costs of elevators in a building, are likely to increase over time as the asset gets older.

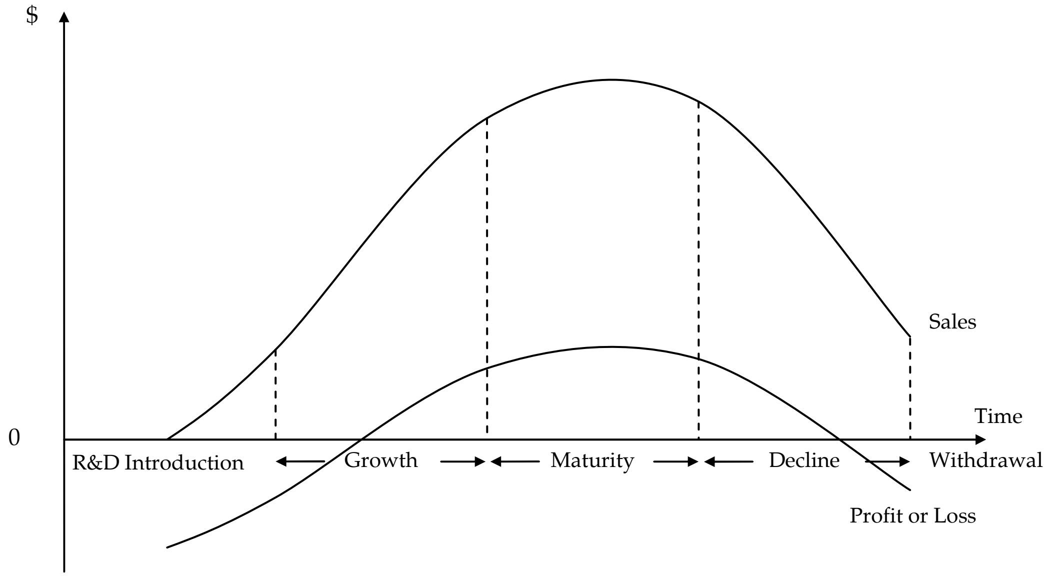
Although costs are incurred throughout the life of an asset, a large proportion of these costs are committed at a very early stage in the product's life cycle, when the decision to develop the new product or construct the new building is made.

2.2 A product life cycle

Most products made in large quantities for selling to customers go through a life cycle. A life cycle consists of several stages:

- research and development of the product (design and development stage)
- introduction to the market
- a period of growth in sales and market size
- a period of maturity and finally
- a period of decline.
- Eventually, a product is withdrawn from the market.

At each stage in the life cycle, total sales revenue and total profits from the product are different. The diagram below indicates what the characteristics of sales revenue and profit are at each stage.



Length of a life cycle

The length of a product life cycle varies between different products. As a general rule:

- a broad type of product may have a long life of several decades
- the product may be produced in several different forms, and the life cycle of each form of the product may be shorter than the total life of the broad product
- a company may produce a form of the product, and the life cycle of a company's product may be shorter than the total life of broad product form.

For example, the life of the television has already been many decades long, and shows no obvious sign of coming to an end. However, the life cycle of the black-and-white picture television set has been shorter, and the end of the life of the analogue television can now be foreseen as flat screen digital televisions take over the market.

As some products of a company reach the end of their life cycle, they need to be replaced with new products. Product innovation is essential to survival. Companies need to have a portfolio of products that:

- provides a profit, and also
- ensures the survival of the company's business in the longer term.

At each phase in its life cycle:

- selling prices will be altered
- costs may differ
- the amount invested (capital investment) may vary
- spending on advertising and other marketing activities may change.

Sales volume, sales revenue, profitability, investment and cash flow will all vary as the product goes through the different stages of its life.

2.3 Research and development phase

This is the phase during which a product is designed and developed for the market. It is at this stage that a large proportion of the life cycle costs are committed, for example capital expenditure decisions are taken and new production systems may be introduced.

Target costing may be used in combination with life cycle costing.

2.4 Introduction phase

When a product is new to the market, and a competitor has not already established a rival product in the market, a company may be able to choose its pricing strategy for the new product.

- If a 'market penetration' strategy is chosen, the aim should be to sell the product at a low price in order to obtain a large share of the market as quickly as possible. This pricing strategy is therefore based on low prices and high volumes.
- If a 'market skimming' strategy is chosen, the aim is to sell the product at a high price in order to maximise the gross profit per unit sold. Sales volumes will be low, and the product will be purchased only by customers who are willing to pay a high price to obtain a 'unique' item. Gradually, the selling price will be reduced, although it will be kept as high as possible for as long as possible. This approach is often used with high technology products.

If a competitor has already introduced a rival product to the market, the selling price should be set at a level to compete for market share with the rival product

During the introduction phase the average cost per unit of production may be high if products are produced in small batches. Marketing costs may be high to establish the product in the market.

The product could therefore make a loss during its initial introductory phase. Even if the product is profitable, unit profits could be low.

At some time during the introductory stage, a decision will have to be made about increasing production quantities to meet rising sales demand. New capital expenditures could be required in order to increase output and sales capacity.

2.5 Growth phase

In the growth phase of a product's life, sales demand grows rapidly, but more competitors enter the market. Companies need to focus on market share and reducing unit costs. Control reduction can be achieved mainly through economies of scale and producing in larger quantities. However, it is also important to ensure that customers believe that they are receiving good value and quality for the price they pay.

It is during the growth stage that a product should be expected to move from making losses to making a profit each year.

2.6 Maturity phase

In the maturity phase of a life cycle, the objective should be to maintain market share. It may be necessary to reduce prices to sustain market share. Alternatively, a company may look for new distribution channels that offer an opportunity to sell at higher prices or at lower costs.

During this phase the product should generate good profits.

2.7 Decline phase

In the decline phase, sales demand starts to fall. Initially the product might be profitable, but profits will fall as sales volume declines and eventually the product ceases to be profitable. The company may continue to sell the product for a tie, provided that the sales price exceeds variable cost. The aim should be to sell any existing inventory and keep production to a minimum. When price falls below variable cost the product should be withdrawn from the market.

However, when a product is withdrawn from the market, the company should consider whether there are any 'end-of-life' costs that will be incurred. The costs of withdrawing from the market, if any, could persuade a company to defer its decision to withdraw the product.

2.8 The implications of using life cycle costing

Traditional costing systems do not attempt to measure the profitability of a product over its entire life.

- Research and development costs are written off as they are incurred
- Profits are measured on a time basis (annual basis) rather than on a 'whole of life' basis
- Non-production costs are not linked to products but are written off as general expenses.

Life cycle costing compares the revenues and costs of the product over its entire life. This has many benefits.

- The potential profitability of products can be assessed before major development of the product is carried out and costs incurred. Non-profit-making products can be abandoned at an early stage before costs are committed.
- Techniques can be used to reduce costs over the life of the product.
- Pricing strategy can be determined before the product enters production. This may lead to better control of marketing and distribution costs.
- Attention can be focused on reducing the research and development phase to get the product to market as quickly as possible. The longer the company can operate without competitors entering the market the more revenue can be earned and the sooner the product will reach the breakeven point.
- By monitoring the actual performance of products against plans, lessons can be learnt to improve the performance of future products. It may also be possible to improve the estimating techniques used.

An understanding of the product life cycle can also assist management with decisions about:

- Pricing
- Performance management
- Decision-making.

Pricing. As a product moves from one stage in its life cycle to the next, a change in pricing strategy might be necessary to maintain market share. For example, prices might be reduced as a product enters its maturity phases (and annual sales volume stops rising).

In addition, an understanding of life cycle costs help with strategic decisions about price. Over the entire life of the product, sales prices should be sufficiently high to ensure that a profit is made after taking into account all costs incurred – start-up costs and end-of-life costs as well as annual operating costs.

Performance management. As a product moves from one stage of its life cycle to another, its financial performance will change. Management should understand that an improvement or decline in performance could be linked to changes in the life cycle and should therefore (to some extent at least) be expected.

Decision-making. In addition to helping management with decisions on pricing, an understanding of life cycle costing can also help with decisions about making new investments in the product (new capital expenditure) or withdrawing a product from the market.

2.9 Life cycle costing and building construction

Life cycle costing is relevant to the construction of buildings and other major items of construction. An international standard on life cycle costing for buildings was published in 2008.

When a building is planned, several different designs might be considered. Each design will have different construction features and therefore a different initial capital cost. Over the life of the building, annual running costs will vary according to the design that is selected. For example:

- Energy-efficient buildings will incur lower energy costs each year
- The choice of construction materials will affect the life of the building and the annual costs of repairs and maintenance
- The choice of design could affect the costs of demolition at the end of the life of the building.

When two or more different building designs are considered, the preferred design might be:

- the design that will achieve the lowest total cost over the life of the building, or
- the design that will provide the most value for money (or benefits less costs) over the life of the building.

Back-flush accounting

- The basic concept of back-flush accounting
- Back-flush accounting and just-in-time production systems
- Traditional costing systems and back-flush accounting compared
- Back-flush accounting with two 'trigger points'
- Back-flush accounting with one 'trigger point'
- Implications of using back-flush accounting

3 Back-flush accounting

3.1 The basic concept of back-flush accounting

Back-flush accounting is a method of cost accounting for a manufacturing environment in which the measurement of costs is delayed until production has been completed, or until the end of an accounting period.

Total costs incurred in producing the output in the period are then worked backwards ('flushed back') and are allocated between cost of sales and closing inventories. No cost accounting records are made until after the end of the period.

This is completely different from traditional cost accounting methods, where costs of production are tracked through the system as production takes place, from raw materials to work in progress and then to finished goods and cost of sales.

3.2 Back-flush accounting and just-in-time production systems

Back-flush accounting is ideally suited to a production system where:

- the production cycle is short (the speed of production is quick) and
- inventories of raw materials and work-in-progress are low.

This makes it suitable for manufacturers that use a just-in-time approach to purchasing and production.

- Just-in-time (JIT) purchasing involves arranging with suppliers for the delivery of materials just before they are needed for production. In theory this would mean holding no inventory at all of raw materials. In practice, when JIT purchasing methods are used, raw materials inventories are very low, but not actually zero.
- Just-in-time JIT) production involves manufacturing items just in time to meet sales demand from customers. Often this means starting production only when a customer order is received. JIT production methods are only practicable when the production time cycle is short, which means that inventories of work-in-progress should be very low.

Transfers between processes are often made at standard cost, and any variances are taken directly as a total variance to the income statement as a gain or a loss.

3.3 Traditional costing systems and back-flush accounting compared

Traditional costing systems

Traditional cost accounting systems for manufacturing costs are 'sequential tracking' systems. They track the costs of items as they progress through the manufacturing process, from raw materials, through work in progress to finished goods. At each stage of the manufacturing process, more costs are added and recorded within the cost accounting system.

- Raw material costs are recorded in a raw materials inventory account when the materials are purchased. When the raw materials are issued to production, a record is made in the cost accounts of the cost of materials issued to production, often using FIFO or weighted average costs to measure the cost of the materials.
- Direct labour costs are recorded in a direct labour cost account, and then transferred to the work in progress account.
- Production overhead costs are calculated by absorbing overheads into production costs at a pre-determined overhead absorption rate. At the end of the period there will be some over- or under-absorbed overheads. Under-absorption is reduced or over-absorption is increased by maximising production volume.

The main benefit of sequential tracking costing systems is that they can be used to put a cost to items of inventory. When inventory is large, there is a need to measure inventory costs with reasonable 'accuracy'.

Features of back-flush accounting

As the term 'back-flush' might suggest, and as explained earlier, costs are calculated after production has been completed. They are allocated between the cost of goods sold and inventories in retrospect. They are not built up as work progresses through the production process.

Back-flush accounting is a method of cost accounting that is consistent with JIT. With a system of JIT purchasing and production, the benefit of 'accurate' costing of inventory does not exist, or is insignificant. Inventory should be small, or even non-existent. The cost of inventory is therefore fairly insignificant. A costing system that measures the cost of inventory is therefore of little or no value, and is certainly not worth the time, effort and expenditure involved.

- With back-flush accounting, there is no work-in-progress account in the costing system. The only inventory accounts in the costing system are an account for finished goods and (possibly) an account for raw materials.
- However there is no need to value raw materials inventory using FIFO or weighted average cost.
- Back-flush accounting also keeps no records of direct labour times and direct labour costs. Labour costs are included with other expenses in a single account for 'conversion costs'. Consequently, the system does not record any direct

labour variances. It simplifies costing accounting, because it ignores labour variances and work-in-progress value.

- There is no need to calculate an absorption rate and absorb production overheads into the cost of production as work progresses through the production system.
- Back-flush accounting systems often make use of standard costs, particularly for the valuation of closing inventory. Standard costs are applied retrospectively, at the end of the costing period.

Back-flush accounting is therefore a much simpler method of costing than traditional costing methods.

However the cost information produced by a system of back-flush accounting is of relatively little value for management, because a detailed analysis of the costs of production does not exist.

3.4 Back-flush accounting with two 'trigger points'

A back-flush accounting system has either one or two 'trigger points'. A trigger point is a point in the production process when entries are made in the cost accounting system.

When there are two trigger points, these are usually:

- the purchase of raw materials and
- the manufacture of completed products.

A numerical example will be used to illustrate the costing method.

Example

Suppose that a manufacturing company operates a JIT system. At the beginning of a period, it has no inventory of raw materials or finished goods. It manufactures a single product, Product P, which has the following standard cost:

	$
Raw materials	20
Direct labour	8
Overheads	22
	50

During the period, it incurred the following costs:

Raw materials purchased	$2,030,000
Direct labour costs incurred	$775,000
Overhead costs incurred	$2,260,000

The company made 100,000 units of Product P and sold 98,000 units.

The company uses a back-flush costing system, with trigger points at raw materials purchase and at completion of production.

Trigger point 1

The purchase of raw materials is recorded in a raw materials inventory account as soon as the purchases occur.

Raw materials inventory account

	$		$
Creditors	2,030,000		

Trigger point 2

The next accounting entries occur at the end of the accounting period, or when production has been completed. In this example, at trigger point 2 when 100,000 units have been produced, the cost of their manufacture is recorded in a finished goods inventory account. Standard costs are used in this example.

Finished goods inventory account

		$		$
Raw materials	(100,000 × 20)	2,000,000		
Conversion costs	(100,000 × 30)	3,000,000		

Here, it is assumed that actual raw materials costs were the same as the standard materials cost. The costs used for finished goods in back-flush accounting need to be close to actual costs to avoid large variances.

Raw materials inventory account

	$		$
Payables	2,030,000	Finished goods inventory	2,000,000
		Closing balance c/f	30,000
	2,030,000		2,030,000

A conversion costs account is used to record the actual and standard costs of labour and production overheads.

Conversion costs account

	$		$
Bank (labour cost)	775,000	Finished goods inventory	3,000,000
Payables (overheads)	2,260,000	Balance (profit or loss)	35,000
	3,035,000		3,035,000

The closing balance on the raw materials account may represent the cost of closing inventory. If so, it is carried forward as an opening balance to the start of the next period. However, any cost variance (difference between standard and actual material cost) should be taken to profit or loss for the period.

Similarly, the balance on the conversion costs account probably represents cost variances for labour and overhead, and this should be written off to profit or loss for the period.

The cost of sales and closing inventory of finished goods are simply recorded as follows:

Finished goods inventory account

		$			$
Raw materials	(100,000 × 20)	2,000,000	Cost of goods sold	(98,000 × 50)	4,900,000
Conversion costs	(100,000 × 30)	3,000,000	Closing inventory	(2,000 × 50)	100,000
		5,000,000			5,000,000

There is no work in progress. The only items recorded in the system are:

Cost of production	$5,000,000
Cost of sales	$4,900,000
Finished goods inventory	$100,000
Raw material purchases	$2,030,000
Raw materials closing inventory	$30,000
Conversion costs incurred	$3,035,000
Written off to profit or loss: conversion costs	$35,000

3.5 Backflush accounting with one 'trigger point'

An even simpler back-flush accounting system has just one trigger point, the manufacture of finished units.

With this system, raw material purchases are not recorded in the system until production is complete (or at the end of the accounting period).

Using the same example, the cost accounting entries would be as follows, starting with finished goods:

Finished goods inventory account

		$			$
Creditors	(100,000 × 20)	2,000,000	Cost of goods sold	(98,000 × 50)	4,900,000
Conversion costs	(100,000 × 30)	3,000,000	Closing inventory	(2,000 × 50)	100,000
		5,000,000			5,000,000

Costs can then be worked back through the system, to conversion costs and raw materials.

Conversion costs account

	$		$
Bank (labour cost)	775,000	Finished goods inventory	3,000,000
Creditors (overheads)	2,260,000	Balance	35,000
	3,035,000		3,035,000

The only difference with the one-trigger point system compared with the two trigger-point system is that in the one trigger-point system, there is no raw materials inventory account. The $30,000 of materials that has been purchased but not used is simply not recorded in the costing system, and is therefore not included in closing inventory at the end of the period.

A one trigger-point system is acceptable when inventories of raw materials are very small.

3.6 Implications of using back-flush accounting

Back-flush accounting avoids the need to maintain a detailed cost accounting system, which can be regarded as a non-value added activity. Costs are worked out retrospectively, and work-in-progress is ignored. This makes the costing system very much simpler than traditional costing methods.

A consequence of a simplified costing system is the loss of management information. The cost records in a system of back-flush accounting provide little or no management information about performance; for example they do not indicate whether production operations have performed well or badly during the period. There are no detailed variances to report, for example.

Management need information about performance in order to control operations effectively. When a system of back-flush accounting is used, performance measurements should come from other sources, and non-financial measures of performance are likely to be used extensively.

Throughput accounting

- The nature of throughput accounting
- Assumptions in throughput accounting
- Throughput, inventory and operating expenses
- Profit and throughput accounting
- The value of inventory in throughput accounting
- Comparing throughput accounting with absorption costing and marginal costing

4 Throughput accounting

4.1 The nature of throughput accounting

Throughput accounting is not really a costing system at all, because with costing no costs are allocated to units of production, with the exception of materials costs.

- With traditional costing systems, the main focus of attention is on costs and how to control or reduce costs.
- With throughput accounting, the main focus of attention is on how to achieve the goals of the entity successfully. For profit-making companies, the goals of the entity are assumed to be the maximisation of profit.

Throughput accounting is also associated wit the Theory of Constraints. This is a theory an entity always has a constraint that sets a limit on the achievement of its goals. The task of management should therefore be to:

- identify what this effective constraint is
- maximise the performance of the entity in achieving its goals, within the limits of this constraint
- look for ways of removing the constraint, so that performance can be improved still further.

Although they are different, throughput accounting has some close similarities with marginal costing and limiting factor analysis, which you should be familiar with from your earlier studies.

4.2 Assumptions in throughput accounting

Throughput accounting is based on a number of assumptions.

- In traditional marginal costing, it is assumed that direct labour costs are a variable cost, but in practice this is not usually correct. Employees are paid a fixed weekly or monthly wage or salary, and labour costs are a fixed cost.
- The only variable cost is the purchase cost of materials and components purchased from external suppliers.

- A business makes real profit by adding value. Value is added by selling goods or services to customers whose market value is more than the cost of the materials that go into making them. However, value is not added until the sale is actually made.
- Value added should be measured as the value of the sale minus the variable cost of sales, which is the cost of the materials.

4.3 Throughput, inventory and operating expenses

Throughput accounting is based on three concepts:

- throughput
- inventory (investment) and
- operating expenses.

Throughput

Throughput can be defined as the rate at which an entity achieves its goals, measured in 'goal units'. In not-for-profit entities, the goal of the entity could be measured in terms of a non-financial goal. For profit-making entities, the goal is profit, and:

Throughput = Sales minus Total variable costs

Throughput differs from contribution in traditional marginal costing because variable costs consist only of real variable costs, which are (mainly or entirely) materials costs.

It is therefore appropriate to define throughput as:

Throughput = Sales minus Cost of raw materials and components

Inventory (or investment)

Inventory or investment is all the money that is tied up in a business, in inventories of raw materials, WIP and finished goods. The term 'investment' is normally preferred to 'inventory' because it includes the amount of capital tied up in making the product and selling it to customers. Investment therefore includes not only the amount invested in inventories but also investment in non-current assets.

Inventory is eventually converted into throughput, but until it is sold it is capital tied up earning nothing. When inventory is sold, throughput is created.

Throughput is not created until finished goods are sold. Creating finished goods for inventory is therefore damaging to the entity's goals, because it ties up finance in investment and investment finance has a cost.

Operating expenses

Operating expenses are all the expenditures incurred to produce the throughput. They consist of all costs that are not variable costs, and so include labour costs.

4.4 Profit and throughput accounting

Profit in throughput accounting is measured as throughput minus operating expenses.

Example

	$
Sales	800,000
Raw materials and components costs	350,000
Throughput	450,000
Operating expenses	340,000
Net profit	110,000

4.5 The value of inventory in throughput accounting

Inventories do not have value, except the variable cost of the materials and components. Even for work-in-progress and inventories of finished goods, the only money invested is the purchase cost of the raw materials. No value is added until the inventory is sold.

- In throughput accounting, all inventory is therefore valued at the cost of its raw materials and components, and nothing more.
- It should not include any other costs, not even labour costs. No value is added by the production process, not even by labour, until the item is sold.
- It is **impossible** to make extra profit simply by producing more output, unless the extra output is sold.

4.6 Comparing throughput accounting with absorption costing and marginal costing

The difference between throughput accounting and the traditional methods of accounting can be illustrated with an example.

Example

A company makes 1,000 units of a product during May and sells 800 units for $32,000. There was no inventory at the beginning of the month. Costs of production were:

	$
Raw materials	6,000
Direct labour	8,000
Fixed production overheads	10,000
Other non-production overheads	5,000

Required

Calculate the profit for the period using:

(a) absorption costing

(b) marginal costing

(c) throughput accounting.

Assume for the purpose of absorption costing that budgeted and actual production overheads were the same, and there are no under- or over-absorbed overheads.

Answer

The value of closing inventory:

Absorption costing: $4,800 ($24,000 × 200/1,000)
Marginal costing: $2,800 ($14,000 × 200/1,000)
Throughput accounting: $1,200 ($6,000 × 200/1,000) in throughput accounting.

Profit for the month using each costing method is therefore as follows:

Absorption costing		**Marginal costing**		**Throughput accounting**	
	$		$		$
Sales	32,000	Sales	32,000	Sales	32,000
Production costs	24,000	Variable production costs	14,000	Materials bought	6,000
Closing inventory	4,800	Closing inventory	2,800	Inventory	1,200
Cost of sales	19,200	Variable costs of sale	11,200		4,800
Gross profit	12,800	Contribution	20,800	Throughput	27,200
Other overheads	5,000	Fixed overheads	15,000	Operating expenses	23,000
Profit	7,800	Profit	5,800	Net profit	4,200

The differences in profit are entirely due to the differences in inventory valuations.

Throughput accounting and constraints

5 Throughput accounting and the Theory of Constraints

5.1 Constraints and bottlenecks in the system

Throughput accounting is derived from the Theory of Constraints, which is based on the view that every system has a constraint. A constraint is anything that limits the output from the system.

- If a system had no constraint, its output would be either zero or the system would continue to produce more and more output without limit.
- Therefore for any system whose output is not zero, there must be a constraint that stops it from producing more output than it does.

Constraints for a manufacturing company might be caused by any of the following:

- external factors, such as a limit to customer demand for the products that the company makes
- weaknesses in the system itself, such as shortages of key resources and capacity limitations
- weaknesses in the system's controls, such as weak management.

In a manufacturing system, constraints can be described as **bottlenecks** in the system. A bottleneck is simply a constraint that limits throughput. For example, a bottleneck might be a shortage of materials, or a shortage of machine time.

5.2 Dealing with constraints

The management of business operations should focus on dealing with the key constraints. The output of a system is restricted by its key constraint. Management must identify what this is.

Action by management to improve operational efficiency is a waste of time and effort if it is applied to any area of operations that is not a constraint. For example, measures to improve labour efficiency are a waste of time if the key constraint is a shortage of machine capacity.

The key constraint limits throughput. As stated earlier, the nature of the key constraint might be:

- limitations on sales demand
- inefficiency in production, with stoppages and hold-ups caused by wastage, scrapped items and machine downtime
- unreliability in the supplies of key raw materials, and a shortage of key materials
- a shortage of a key production resource, such as skilled labour.

Goldratt, who developed the Theory of Constraints, argued that:

- Management should identify the key constraint and consider ways of removing or easing the constraint, so that the system is able to produce more output.
- However, when one constraint is removed, another key constraint will take its place.
- The new key constraint must be identified, and management should now turn its attention to ways of removing or easing the new key constraint.
- By removing constraints one after another, the output capacity of the system will increase.

However, there will always be a key constraint.

5.3 The relevance of constraints to throughput accounting

Goldratt argued that if the aim of a business is to make money and profit, the most appropriate methods of doing this are to:

- increase throughput
- reduce operating expenses, or
- reduce investment, for example by reducing inventory levels (since there is a cost to investment).

Goldratt also argued that the most effective of these three ways of increasing profit is to increase throughput.

Throughput can be increased by identifying the bottlenecks in the system, and taking action to remove them or ease them.

5.4 Performance measurement ratios in throughput accounting

There are several key performance measurements in throughput accounting.

One of these is net profit, which is total throughput minus Operating expenses.
An objective is to increase net profit.
Performance can also be measured using ratios:

- Return on investment
- Throughput accounting productivity
- Throughput per unit of the bottleneck resource

- Operating expenses per unit of the bottleneck resource
- Throughput accounting ratio.

Return on investment

This is measured as:

$$\frac{\text{Net profit}}{\text{Investment}} \times 100\%$$

An objective should be to increase the return on investment, either by increasing net profit or reducing the size of the investment.

Throughput productivity

This is measured as:

$$\frac{\text{Throughput}}{\text{Operating expenses}} \times 100\%$$

An objective should be to increase throughput productivity, either by increasing throughput or reducing operating expenses.

Throughput per unit of constraint

One of the advantages of throughput accounting is that it treats labour costs as a fixed cost. In many manufacturing companies, where the production process has been automated, direct labour costs are not a significant part of total production costs.

However traditional costing systems treat direct labour as a variable cost and assume that variable overheads vary with labour hours. In addition, fixed overheads might be absorbed on a labour hour basis. It is often assumed that performance will be improved by improving labour efficiency.

Throughput accounting challenges this approach to costs and performance measurement. Labour is a fixed cost and relatively small compared to other costs. Improving labour efficiency will therefore do little to improve performance and increase profits.

Net profit will be improved much more effectively by identifying the constraint on activity and seeking to maximise throughput per unit of the constraint.

Throughput accounting ratio

The throughput accounting ratio is the ratio of [throughput in a period per unit of bottleneck resource] to [operating expenses per unit of bottleneck resource].

Units of a bottleneck resource are measured in hours (labour hours or machine hours). This means that the throughput accounting ratio can be stated as:

$$\text{Throughput accounting ratio} = \frac{\text{Throughput per hour of bottleneck resource}}{\text{Operating expenses per hour of bottleneck resource}}$$

Example

A business manufactures product Z, which has a selling price of \$20. The materials costs are \$8 per unit of Product Z. Total operating expenses each month are \$120,000.

Machine capacity is the key constraint on production. There are only 600 machine hours available each month, and it takes three minutes of machine time to manufacture each unit of Product Z.

Required

(a) Calculate the throughput accounting ratio.

(b) How might this ratio be increased?

Answer

(a) Throughput per unit = \$(20 – 8) = \$12

Throughput per machine hour = \$12 × (60 minutes/3 minutes) = \$240

$$\text{Operating expenses per machine hour} = \frac{\$120{,}000}{600 \text{ hours}} = \$200$$

$$\text{Throughput accounting ratio} = \frac{\$240}{\$200} = 1.20$$

(b) To increase the throughput accounting ratio, it might be possible to:

- Raise the selling price for Product Z for each unit sold, to increase the throughput per unit.
- Improve the efficiency of machine time used, and so manufacture Product Z in less than three minutes.
- Find ways of reducing total operating expenses, in order to reduce the operating expenses per machine hour.

5.5 Throughput accounting and decision-making

When a company can make more than one product, throughput per unit of constraint factor can be used to rank products in order of priority for production.

Example

A company manufactures a single product, X, for which the sales price is \$350 per unit and the material cost per unit is \$75.
Product X is made in two consecutive production operations, which are carried out in Department P1 and Department P2. The capacity per month in each department is 6,400 hours.

Conversion costs per week in each department are as follows:

	Department P1	**Department P2**
Conversion costs per month	$73,600	$32,000
Hours per month capacity	6,400	6,400
Conversion cost per hour	$11.50	$5

The company is operating at full capacity, and it makes and sells 400 units of Product X each month.

It has now been offered an opportunity to make and sell 150 units of a Product Y each month to a large customer, who will pay $310 per unit. The direct material cost per unit of Product Y would be $150. Product Y would be made in departments P1 and P2, and the production time required per unit would be as follows:

	Product X	**Product Y**
	hours per unit	hours per unit
Department P1	8	12
Department P2	16	6

On the basis of 'traditional costing', the decision would be to reject the customer order for 1,500 units of Product Y per month, because Product Y would appear to make a loss.

	Product X	**Product Y**
	$	$
Direct materials	75	150
Conversion costs		
P1 at $11.50 per hour	92	138
P2 at $5 per hour	80	30
Total cost per unit	247	318
Sales price	350	310
Profit/(loss) per unit	103	(8)

However, this would be an incorrect decision if the goal is to maximise profit. There is currently spare capacity in Department P1, but time in Department P2 is a key constraint. Profit is maximised by maximising throughput per hour worked in Department P2.

	Product X	**Product Y**
	$	$
Sales price	350	310
Direct materials cost	75	150
Throughput per unit	275	160
Hours per unit in Department P2	16	6

Throughput per P2 hour	$17.19	$26.67

The optimal production plan is to make 150 units of Product Y per month, and use the rest of the time to make units of Product X.

Current production plan: Make and sell 400 units of X

	$	$
Total throughput: 400 × $275		110,000
Operating expenses		
Department P1	73,600	
Department P2	32,000	
Total operating expenses		105,600
Net profit		4,400

The optimum production plan is to make 150 units of Product Y, which would require (× 6 hours per unit) 900 hours per month. This would leave 5,500 hours of time in Department P2 to make Product X: this would be sufficient time for (5,500/16 hours per unit) 343 units per month.

(**Note**: Making 150 units of Y and 343 units of X would require a total of 4,544 hours in Department P1 per month. Time in Department P2 is therefore still the key constraint.)

Optimal production plan: 150 units of Y and 343 units of X

	$
Product Y: 150 × $160	24,000
Product X: 343 × $275	94,325
Total throughput	118,325
Operating expenses	105,600
Net profit	12,725

Net profit per month would increase by $8,325.

CHAPTER 3

Limiting factors and linear programming

Contents

Costs for decision-making

- Management information for making decisions
- Using marginal costing for decision-making

1 Costs for decision-making

1.1 Management information for making decisions

One of the functions of management is to make decisions about how to run the business. Decisions involve making a choice about what should be done, between different possible options. To help them make good-quality decisions, managers need reliable and relevant information.

Both financial and non-financial information is needed to make decisions. This chapter (and the chapters that follow) concentrate mainly on financial information for decision-making, but it is useful to remember that factors of a non-financial nature will often influence the choices that managers make.

Since it is often assumed that the aim of a business should be to maximise profits, financial information to assist managers with decision-making will consist mainly of information about revenues and costs.

Information for decision-making is different from information about historical costs. This is because decisions are concerned with the future, not what has happened in the past:

- Information about costs and revenues, to assist with decision-making, should be about **future costs and future revenues.**
- Decisions should be concerned with **cash and cash flow**. Only those costs and revenues that represent cash flow are relevant to decision-making. Non-cash items of cost or revenue, such as depreciation or absorbed fixed overheads, are not relevant for decision-making. The conventions of financial accounting and financial reporting, such as the accruals concept, are irrelevant for business decisions.
- It is assumed for the purpose of providing cost information for decision-making that the aim or **objective is to maximise profit**.
- **Historical costs are irrelevant** for decision-making, because they are not future costs. Costs that have been incurred in the past are 'sunk costs': they have already happened, and any decision taken now cannot affect what has already happened in the past.
- However, historical costs can provide a guide to what future costs will be. Historical costs might therefore be used as information for decision-making, but only because they provide an estimate of what costs will be in the future.

These principles of relevant costs and revenues should be applied to all decision-making by management.

Principles of relevant costing will be explained in more detail in a later chapter, but a useful definition of relevant costs and revenues is as follows:

Relevant costs and revenues are future cash flows that would arise as a direct consequence of a decision being taken.

1.2 Using marginal costing for decision-making

It is often assumed that marginal costs are relevant costs for the purpose of decision-making.

- The marginal cost of a product is the extra cost that would be incurred by making and selling one extra unit of the product.
- Similarly, the marginal cost of an extra hour of direct labour work is the additional cost that would be incurred if a direct labour employee worked one extra hour. When direct labour is a variable cost, paid by the hour, the marginal cost is the variable cost of the direct labour wages plus any variable overhead cost related to direct labour hours.

Examples of the use of marginal costing for decision-making are:

- **Planning decisions:** marginal costing can be used to estimate future profits. This can be very useful when a company prepares its annual budget.
- **Limiting factor decisions.** Marginal costing is also used when there is a shortage of a key resource, such as materials or skilled labour, to identify the output plan that will maximise profits.
- **Make or buy decisions.** When there is a choice between making an item in-house or buying it externally from a sub-contractor, marginal costing can be used to decide on the profit-maximising programme for buying externally.

This chapter focuses on decision-making when there are limiting factors that restrict operational capabilities. Decision-making techniques for limiting factor situations are based on the assumption that as a normal rule:

- marginal costs or variable costs are the only relevant costs to consider, and
- fixed costs will be the same whatever decision is taken; therefore fixed costs are not relevant to the decision.

Limiting factor decisions: single limiting factor

- Definition of a limiting factor
- Maximising profit when there is a single limiting factor
- Identifying limiting factors

2 Limiting factor decisions: single limiting factor

2.1 Definition of a limiting factor

It is often assumed in budgeting that a company can produce as many units of its products (or services) as is necessary to meet the available sales demand. Sales demand is therefore normally the factor that sets a limit on the volume of production and sales in each period.

Sometimes, however, there could be a shortage of a key production resource, such as an item of direct materials, or skilled labour, or machine capacity. In these circumstances, the factor setting a limit to the volume of sales and profit in a particular period is the availability of the scarce resource, because sales are restricted by the amount that the company can produce.

If the company makes just one product and a production resource is in limited supply, profit is maximised by making as many units of the product as possible with the limited resources available.

However when a company makes and sells more than one different product with the same scarce resource, a budgeting problem is to decide how many of each different product to make and sell in order to maximise profits.

2.2 Maximising profit when there is a single limiting factor

When there is just one limiting factor (other than sales demand), total profit will be maximised in a period by maximising the total contribution earned with the available scarce resources.

- The objective should be to maximise total contribution.
- This will be achieved by making the optimum use of the scarce resource and maximising the contribution earned from each unit of the scarce resource that is used.
- Products should therefore be ranked in order of priority for manufacture and sale according to the **contribution earned by each product (or service) for each unit of the scarce** resource that the product uses.
- The products or services should be produced and sold in this order of priority, up to the maximum expected sales demand for each product.

- The planned output and sales should be decided by working down through the priority list until all the units of the limiting factor (scarce resource) have been used.

In other words, in order to maximise profit, the aim should be to maximise the contribution for each unit of limiting factor used.

Example

A company makes four products, A, B, C and D, using the same direct labour work force on all the products. Budgeted data for the company is as follows:

Product	**A**	**B**	**C**	**D**
Annual sales demand (units)	4,000	5,000	8,000	4,000
	$	$	$	$
Direct materials cost	3.0	6.0	5.0	6.0
Direct labour cost	6.0	12.0	3.0	9.0
Variable overhead	2.0	4.0	1.0	3.0
Fixed overhead	3.0	6.0	2.0	4.0
Full cost	14.0	28.0	11.0	22.0
Sales price	15.5	29.0	11.5	27.0
Profit per unit	1.5	1.0	0.5	5.0

The company has no inventory of finished goods. Direct labour is paid $12 per hour. To meet the sales demand in full would require 12,000 hours of direct labour time. However, only 6,000 direct labour hours are available during the year.

Required

Identify the quantities of production and sales of each product that would maximise annual profit.

Answer

Direct labour hours are a scarce resource. The products should be ranked in order of priority according to the contribution that they make per direct labour hour.

	A	**B**	**C**	**D**
	$	$	$	$
Sales price/unit	15.5	29.0	11.5	27.0
Variable cost/unit	11.0	22.0	9.0	18.0
Contribution per unit	4.5	7.0	2.5	9.0
Direct labour hours/unit	0.5	1.0	0.25	0.75
Contribution/direct labour hour	$9.0	$7.0	$10.0	$12.0
Priority for making and selling	3rd	4th	2nd	1st

The products should be made and sold in the order D, C, A and then B, up to the total sales demand for each product and until all the available direct labour hours (limiting factor resources) are used up.

Profit-maximising budget

Product	Sales units	Direct labour hours	Contribution per unit	Total contribution
			$	$
D (1st)	4,000	3,000	9.0	36,000
C (2nd)	8,000	2,000	2.5	20,000
A (3rd)	2,000 (balance)	1,000	4.5	9,000
		6,000		65,000

2.3 Identifying limiting factors

You might not be told by an examination question that a limiting factor exists, although you might be told that there is a restricted supply of certain resources. You might be expected to identify the limiting factor by calculating the budgeted availability of each resource and the amount of the resource that is needed to meet the available sales demand.

Example

A company manufactures and sells two products, Product X and Product Y. The two products are manufactured on the same machines. There are two types of machine, and the time required to make each unit of product is as follows:

	Product X	Product Y
Machine type 1	10 minutes per unit	6 minutes per unit
Machine type 2	5 minutes per unit	12 minutes per unit

Sales demand each year is for 12,000 units of Product X and 15,000 units of Product Y.

The contribution per unit is $7 for Product X and $5 for Product Y.

There is a limit to machine capacity, however, and in each year there are only 3,000 hours of Machine 1 time available and 4,200 hours of Machine 2 time available.

Required

Recommend what the company should make and sell in order to maximise its annual profit.

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Answer

The first step is to identify whether or not there is any limiting factor other than sales demand. Clearly, the time available on either machine type 1 or machine type 2 could be a limiting factor. To find out whether machine time on either type of machine is a limiting factor, we calculate the required machine time to manufacture units of Product X and Y to meet the sales demand in full. We then compare this requirement for machine time with the actual time available.

	Machine type 1	**Machine type 2**
	hours	hours
Time required		
To make 12,000 units of Product X	2,000	1,000
To make 15,000 units of Product Y	1,500	3,000
Hours needed to meet sales demand	3,500	4,000
Hours available	3,000	4,200
Shortfall	(500)	-

Machine type 1 is a limiting factor, but Machine type 2 is not. To maximise contribution and profit, we should therefore give priority to the product that gives the higher contribution per hour of machine type 1.

	Product X	**Product Y**
Contribution per unit	\$7	\$5
Machine type 1 time per unit	10 minutes	6 minutes
Contribution per hour (Machine type 1)	\$42	\$50
Priority for making and selling	2nd	1st

Profit-maximising budget

Product	**Sales units**	**Machine type 1 hours**	**Contribution per unit**	**Total contribution**
			\$	\$
Y (1st)	15,000	1,500	5.0	75,000
X (2nd) - balance	9,000	1,500	7.0	63,000
		3,000		138,000

Limiting factor decisions: linear programming

- Two or more limiting factors
- Formulating a linear programming problem
- The objective function
- Formulating the constraints

3 Limiting factor decisions: linear programming

3.1 Two or more limiting factors

There may be more than one scarce resource or limiting factor. When there is more than one limiting factor (other than sales demand for the products), the contribution-maximising plan cannot be identified simply by ranking products in order of contribution per unit of limiting factor, because the ranking provided by each limiting factor could be different.

The problem is still to decide what mix of products should be made and sold in order to maximise profits. It can be formulated and solved as a linear programming problem.

- The problem must first be formulated.
- Having formulated the problem, it must then be solved.

3.2 Formulating a linear programming problem

A linear programming problem is formulated by:

- identifying an objective function, and
- formulating two or more constraints, one for each limiting factor or other possible restriction on output and sales (such as maximum sales demand).

3.3 The objective function

The objective of a linear programming problem is to maximise or minimise the value of something. For the purpose of your examination, it is likely to be the objective of maximising total contribution. (The objective might possibly be something else, such as the objective of minimising costs.)

An objective function expresses the objective, such as total contribution, as a formula.

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Example

A company makes and sells two products, Product X and Product Y. The contribution per unit is $8 for Product X and $12 for Product Y. The company wishes to maximise profit.

If it is assumed that total fixed costs are the same at all levels of output and sales, the objective of the company is to maximise total contribution.

Total contribution can be expressed as a formula, as follows:

Let the number of units (made and sold) of Product X be x
Let the number of units (made and sold) of Product Y be y

The objective function is therefore to maximise:

(Total contribution): $8x + 12y$.

3.4 Formulating the constraints

In a linear programming problem, there is a separate constraint for each item that might put a limitation on the objective function.

Each constraint, like the objective function, is expressed as a formula. Each constraint must also specify the amount of the limit or constraint.

If there is a **maximum limit**, the constraint must be expressed as 'must be equal to or less than'.

For example, if there is a maximum sales demand for Product X of 5,000 units, the constraint for sales demand for X would be expressed as:

$x \leq 5{,}000$.

Similarly, if there is a **minimum limit**, the constraint must be expressed as 'must be equal to or more than'. For example, if there is a requirement to supply a customer with at least 2,000 units of Product X, this constraint would be expressed as:

$x \geq 2{,}000$.

Constraints will often involve two (or more) variables. For example, suppose that a company makes two products, X and Y, using the same direct labour employees. It takes 2 hours to make one unit of X and 3 hours to make one unit of Y. In the budget period, only 18,000 direct labour hours will be available. The constraint will be:

$2x + 3y \leq 18{,}000$.

Non-negativity constraints

A requirement of linear programming problems is that there should be no negative values in the final solution. For example, it is not possible to make and sell *minus 4,000* units of Product Y.

Constraints in the linear programming problem should therefore be that each 'variable' must be equal to or greater than 0.

For example:

(Non-negativity constraint): x, y ≥ 0.

Example

A company makes and sells two products, Product X and Product Y. The contribution per unit is $8 for Product X and $12 for Product Y. The company wishes to maximise profit.

The expected sales demand is for 6,000 units of Product X and 4,000 units of Product Y. However, there are limitations to the amount of labour time and machine time that is available in the period:

	Product X	**Product Y**
Direct labour hours per unit	3 hours	2 hours
Machine hours per unit	1 hour	2.5 hours

	Total hours
Direct labour hours available, in total	20,000
Machine hours available, in total	12,000

A linear programming problem can be formulated as follows:

Let the number of units (made and sold) of Product X be x
Let the number of units (made and sold) of Product Y be y

The objective function is to maximise total contribution: 8x + 12y.

Subject to the following constraints:

Direct labour	3x + 2y	≤	20,000
Machine time	x + 2.5y	≤	12,000
Sales demand, X	x	≤	6,000
Sales demand, Y	y	≤	4,000
Non-negativity	x, y	≥	0

If you do not like figures with fractions in a constraint, the constraint for machine time could be expressed (by doubling it) as:

Machine time	$2x + 5y$	$\leq$	24,000

Conclusion: formulating a linear programming problem

Once a linear programming problem has been formulated, it must then be solved to decide how the objective function is maximised (or minimised).

Linear programming: graphical solution

- The stages in a graphical solution
- Drawing the constraints on a graph
- Maximising (or minimising) the objective function
- Calculating the value for the objective function
- An alternative approach to a solution

4 Linear programming: graphical solution

When there are just two variables in a linear programming problem (x and y), the problem can be solved by a graphical method. The solution identifies the values of x and y that maximise (or minimise) the value of the objective function.

4.1 The stages in a graphical solution

There are three stages in solving a linear programming problem by the graphical method:

- **Step 1**: Draw the constraints on a graph, to establish the feasible combinations of values for the two variables x and y that are within all the constraints in the problem.
- **Step 2**: Identify the combination of values for x and y, within this feasible area, that maximises (or minimises) the objective function. This is the solution to the problem.
- **Step 3**: Calculate the value for the objective function that this solution provides.

4.2 Drawing the constraints on a graph

The constraints in a linear programming problem can be drawn as straight lines on a graph, provided that there are just two variables in the problem (x and y). One axis of the graph represents values for one of the variables, and the other axis represents values for the second variable.

The straight line for each constraint is the boundary edge of the constraint – its outer limit in the case of maximum amounts (and inner limit, in the case of minimum value constraints).

For example, suppose we have a constraint:

$2x + 3y \leq 600$

The outer limit of this constraint is represented by a line:

$2x + 3y = 600$.

Combinations of values of x and y beyond this line on the graph (with higher values for x and y) will have a value in excess of 600. These exceed the limit of the constraint, and so cannot be feasible for a solution to the problem.

The constraint is drawn as a straight line. To draw a straight line on a graph, you need to plot just two points and join them up. The easiest points to plot are the combinations of x and y:

- where x = 0, and
- where y = 0.

For the equation 2x + 3y = 600:

- when x = 0, y = 200 (600/3). So plot the point x = 0, y = 200 on the graph
- when y = 0, x = 300 (600/2). So plot the point y = 0, x = 300 on the graph

Join these two points, and you have a line showing the values of x and y that are the maximum possible combined values that meet the requirements of the constraint.

Example

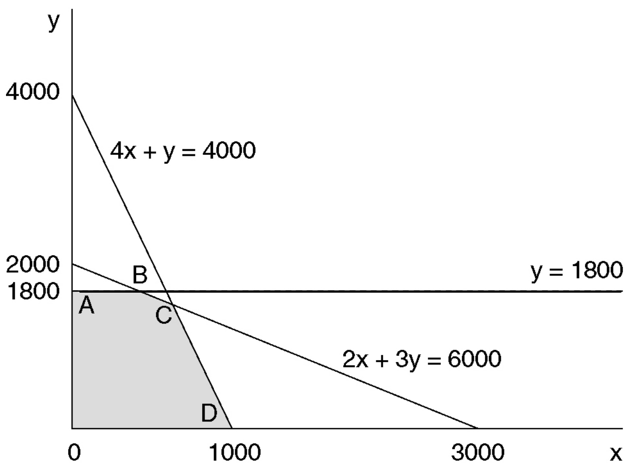
Suppose that we have the following linear programming problem:

The objective function is to maximise total contribution: 5x + 5y

Subject to the following constraints:

Direct labour	2x + 3y	≤	6,000
Machine time	4x + y	≤	4,000
Sales demand, Y	y	≤	1,800
Non-negativity	x, y	≥	0

The non-negativity constraints are represented by the lines of the x axis and y axis. The other three constraints are drawn as follows, to produce a combination of values for x and y that meet all three constraints. These combinations of values for x and y represent the 'feasible region' on the graph for a solution to the problem.



Workings

(1) Constraint 2x + 3y = 6,000
When x = 0, y = 2,000. When y = 0, x = 3,000.

So draw a line between 2,000 on the y axis and 3,000 on the x axis to get the constraint line.

(2) Constraint $4x + y = 4{,}000$
When $x = 0$, $y = 4{,}000$. When $y = 0$, $x = 1{,}000$.
So draw a line between 4,000 on the y axis and 1,000 on the x axis to get the constraint line.

(3) Constraint $y = 1{,}800$
Draw a line parallel to the x axis from the point $y = 1{,}800$ on the y axis.

Feasible area (or feasible region) for a solution

The feasible area for a solution to the problem is shown as the shaded area OABCD. Combinations of values for x and y within this area can be achieved within the limits of the constraints. Combinations of values of x and y outside this area are not possible, given the constraints that exist.

To solve the linear programming problem, we now need to identify the feasible combination of values for x and y (the combination of x and y within the feasible area) that maximises the objective function.

4.3 Maximising (or minimising) the objective function

As a starting point, you might recognise that the combination of values for x and y that maximises the objective function will be a pair of values that lies somewhere along the outer edge of the feasible area.

In the graph above, the solution to the problem will normally be the values of x and y at one of the following points on the graph:

- A
- B
- C, or
- D

In other words, we will normally expect the solution to be the combination of values for x and y that lies at one of the 'corners' of the outer edge of the feasible area.

(In some cases, the solution might be:

- any combination of values of x and y along the line AB, or
- any combination of values of x and y along the line BC, or
- any combination of values of x and y along the line CD.

However, this would be unusual.)

To identify the combination of values for x and y that are feasible (within all the constraints) and that also maximises the objective function, we need to look at the objective function itself.

Iso-contribution lines

We do not know the maximum value (or minimum value) for the objective function. However, we can draw a line that shows all the combinations of x and y that provide the same total value for the objective function.

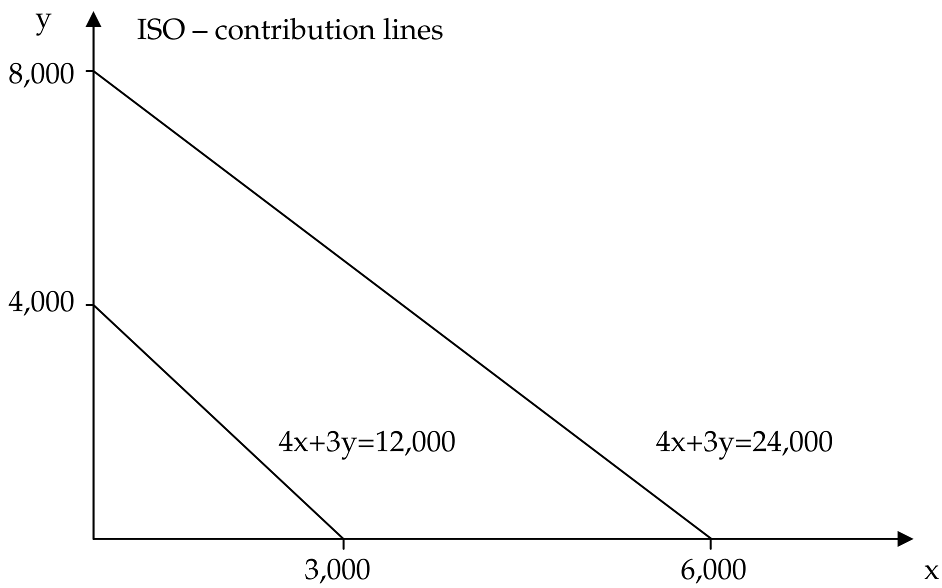
For example, suppose that the objective function is to maximise contribution 4x + 3y. We can draw a line on a graph that shows combinations of values for x and y that give the same total contribution, when x has a contribution of 4 and y has a contribution of 3. Any total contribution figure can be chosen, but a convenient multiple of 4 and 3 is simplest and easiest.

- For example, we could select a total contribution value of 4x + 3y = 12,000. This contribution line could be found by joining the points on the graph x = 0, y = 4,000 and y = 0, x = 3,000.
- Instead, we might select a total contribution value of 4x + 3y = 24,000. This contribution line could be found by joining the points on the graph x = 0, y = 8,000 and y = 0, x = 6,000.

A line showing combinations of x and y that would earn the same total contribution is sometimes called an iso-contribution line. ('Iso' means 'the same'.)

If you draw both of these iso-contribution lines on a graph, you will find that:

- the two lines are parallel to each other on the graph, and
- the line with the higher total contribution value for values of x and y (24,000) is further away from the origin of the graph (point 0).



This can be used to identify the solution to a linear programming problem.

- On the graph showing the feasible area, draw an iso-contribution line. Choose any iso-contribution line that is easy to draw on the graph. The total value of the line doesn't matter, because all you are trying to find out is the slope of the line, and the slope is the same for every iso-contribution line.

- Having established the slope of an iso-contribution line, the next step is to identify the point in the feasible area on the graph where an iso-contribution line can be drawn which is as far from the origin of the graph as possible.
- Look at the slope of the contribution line, and (using a ruler if necessary) identify which combination of values of x and y within the feasible area for the constraints is furthest away from the origin of the graph, through which you could draw an iso-contribution line. This is usually the combination of values for x and y at one corner of the feasible area.
- In other words, you can use the iso-contribution line you have drawn to identify the point in the feasible area that will maximise total contribution.

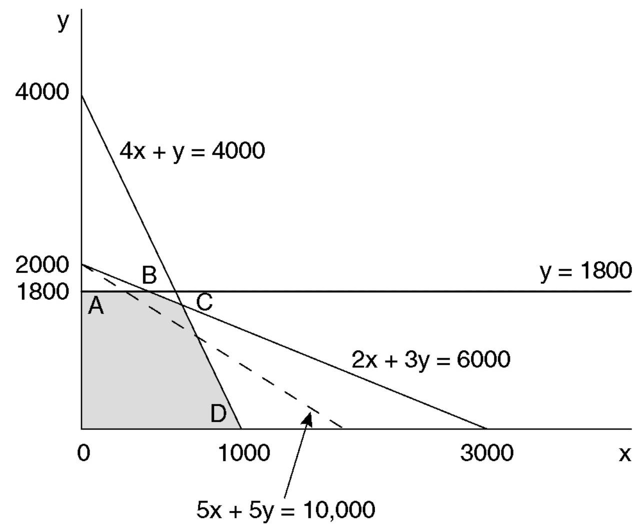
This is the combination of values of x and y that provides the solution to the linear programming problem.

Example

Returning to the previous example, we can draw an iso-contribution line for, say, 5x + 5y = 10,000, by joining the points x = 0, y = 2,000 and y = 0, x = 2,000. (The value 10,000 is chosen here as a convenient multiple of the values 5 and 5 that can be drawn clearly on the graph.)

This should show that the combination of values of x and y that will maximise total contribution lies at point C on the graph. An iso-contribution line going through point C would be further from the origin than an iso-contribution line going through point B (and is obviously further from the origin than an iso-contribution lines going through point A and point D).

The combination of x and y at point C is therefore the solution to the linear programming problem.



4.4 Calculating the value for the objective function

Having identified which combination of values for x and y provides the solution to the linear programming problem, the final step is to:

- establish the exact values for x and y at this point, and
- use these values to calculate the value of the objective function at this point.

It might be possible to read the value of x and y from the graph, but it is sensible to measure the values of x and y exactly by solving two simultaneous equations for the values of x and y.

Simultaneous equations are equations that are both correct at the same time.

The simultaneous equations in the solution to a linear programming problem are the equations for the two constraint lines at the point on the graph that provides the solution. In this example, these are the equations at point C on the graph.

Example

At point C, we have the simultaneous equations:

$2x + 3y = 6{,}000$
$4x + y = 4{,}000$

You should know how to solve simultaneous equations. However, if you are not sure, the technique is to multiply one or both of the simultaneous equations so that you obtain two equations where the coefficient for either x or y is the same. You can then subtract one equation from the other (or possible add them together, if minus values for coefficients are involved). This will allow you to calculate the value for wither x or y.

Having obtained a value for x or y, you can then substitute this value in any of the simultaneous equations to obtain the value for the other variable.

In this example the simultaneous equations are solved as follows:

(1)	2x + 3y	=	6,000
(2)	4x + y	=	4,000
Multiply (1) by 2:			
(3)	4x + 6y	=	12,000
The coefficient for x is 4 in both (2) and (3)			
Subtract (2) from (3):			
	5y	=	8,000
Therefore	y	=	1,600
Substitute in equation (2)			
	4x + 1,600	=	4,000
	4x	=	2,400
	x	=	600

The total contribution is maximised by producing 600 units of X and 1,600 units of Y.

The objective in this problem is to maximise 5x + 5y.

The total contribution where x = 600 and y = 1,600 is:
5 (600) + 5 (1,600) = $11,000.

This is the amount of the maximum achievable contribution.

4.4 An alternative approach to a solution

If you find the iso-contribution line method confusing, there is an alternative method of identifying the solution to a linear programming problem.

When you have drawn the feasible area on a graph, and you have identified the feasible combinations of values for x and y, you will know that the solution lies at one of the corners of the feasible area.

In the previous example, the solution has to be at points A, B, C or D.

You can calculate the values of x and y at each of these points, using simultaneous equations if necessary to calculate the x and y values. Having established the values of x and y at each of the points, calculate the value of the objective function (total contribution) for each.

The solution is the combination of values for x and y at the point where the total contribution is highest.

However, you must learn how to solve a linear programming problem using the graphical method with iso-contribution lines, because this might be a specific requirement of an exam question.

Linear programming: shadow prices and slack

- Shadow prices
- Calculating a shadow price
- Implications of shadow prices
- Slack

5 Linear programming: shadow prices and slack

5.1 Shadow prices

In a linear programming problem, every constraint has a shadow price. (A shadow price is also called a **dual price**.)

A shadow price is the amount by which the value of the objective function would change in the optimal solution if the constraint was one unit extra (or one unit less).

- For example, suppose that direct labour hours are a constraint in a linear programming problem, and the maximum labour time available is restricted to 20,000 hours. If the objective function is to maximise contribution, the shadow price of direct labour is the amount by which total contribution could be increased in 20,001 labour hours were available (and the amount by which total contribution would be reduced if only 19,999 labour hours were available).
- Similarly suppose that in a linear programming problem there is a maximum sales demand of 1,800 units for Product Y. The shadow price of sales demand for Product Y is the amount by which total contribution in the optimal solution would increase if the maximum sales demand were 1,801 units (of the amount by which total contribution would fall if maximum sales demand were 1,799 units).

5.2 Calculating a shadow price

The shadow price of an item cannot be a negative value. However, if it is not a limiting factor in the optimal solution to the linear programming problem, the shadow price of an item will be $0.

When an item is an actual limiting factor in the solution to a linear programming problem, this means that in the optimal solution, the limit of the constraint has been reached. The item therefore has a shadow price with a positive value.

When the graphical method of solving a linear programming problem is used, the shadow prices of the constraining items (effective limiting factors) are calculated as follows.

- The shadow price for each constraining item (effective limiting factor) should be calculated one at a time.

- Identify the constraints in the optimal solution to the linear programming problem.
- Take one of the constraints in that solution and increase the limit of the constraint by one unit.
- Calculate the optimal solution when this constraint has been increased. The optimal solution will be at the point on the graph where the same constraint lines intersect, so calculate the solution using simultaneous equations.
- Compare the value of the objective function with the new constraint with the value of the objective function in the original linear programming problem. The amount by which the total value of the objective function (total contribution) has increased is the shadow price of the item.

The same technique can be used to calculate the shadow price of any other effective limiting factor in the original solution.

Example

A company makes two products B and C. Product B earns a contribution of $10 per unit and a unit of Product C earns a contribution of $30.

The following resources are used to make one unit of each product:

	Product B	**Product C**	**Maximum resource available**
Machine type 1	30 minutes	10 minutes	15 hours per day
Machine type 2	40 minutes	45 minutes	30 hours per day
Skilled labour	20 minutes	30 minutes	15 hours per hay

The maximum sales demand for C is 20 units per day. The sales demand for Product B is unlimited.

Required
Calculate the optimum production plan for the baker and the shadow prices of resources.

Answer

Let x = the number of units of Product B per day

Let y = the number of units of Product C per day

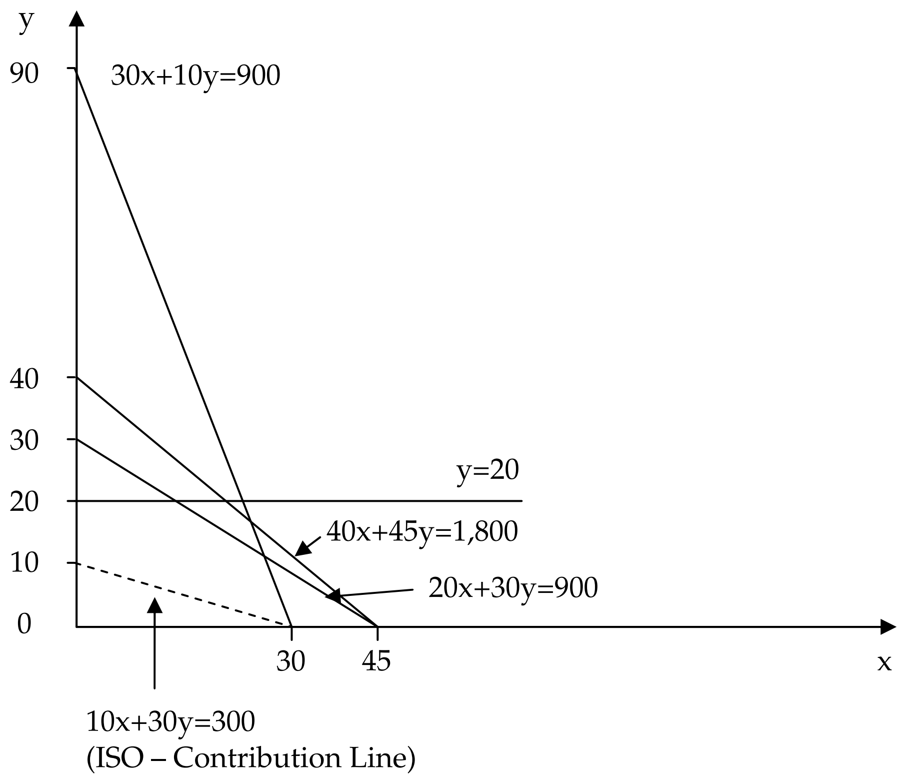
The objective function is to maximise:
(Total contribution): 10x + 30y.

Subject to the constraints:

Machine type 1	$30x + 10y \leq 900$
Machine type 2	$40x + 45y \leq 1,800$
Skilled labour	$20x + 30y \leq 900$

Demand for C	$y \leq 20$
Minimum production	$x \geq 0, y \geq 0$

A graph can be drawn as follows to identify the feasible area for a solution. This is shown below. The feasible area is 0ABCD, and the optimal solution is at point A, point B, point C or point D.



An iso-contribution line $10x + 30y = 300$ has been drawn to establish the slope of the objective function. This can be used to identify the optimal solution, which is at point B.

At point B, the effective constraints are sales demand ($y = 20$) and skilled labour ($20x + 30y = 900$).

Since $y = 20$: $20x + (30 \times 20) = 900$
Therefore $20x = 300$ and $x = 15$.

Total contribution at the optimal solution is therefore $(15 \times \$10) + (20 \times \$30) = \$750$ per day.

Shadow price of skilled labour

If the available skilled labour could be increased from 900 minutes to 901 minutes per day, the optimal solution would be at a point where:

(1)	y	=	20
(2)	$20x + 30y$	=	901

Multiply (1) by 30:			
(3)	30y	=	600
Subtract (3) from (2)	20x	=	301
	x	=	15.05

	$
Total contribution with new labour constraint:	
Product C: 20 × $30	600.0
Product B: 15.05 × $10	150.5
Total contribution	750.0
Total contribution with original constraint for labour	750.0
Shadow price of skilled labour, per minute	0.5

The shadow price of skilled labour is therefore $0.50 per minute, or $30 per hour.

Shadow price of sales demand for Product C

If the maximum demand for Product C could be increased to 21 units per day, the optimal solution would be at the point where:

(1)	y	=	21
(2)	20x + 30y	=	900
Multiply (1) by 30:			
(3)	30y	=	630
Subtract (3) from (2)	20x	=	270
	x	=	13.5

	$
Total contribution with new labour constraint:	
Product C: 21 × $30	630.0
Product B: 13.5 × $10	135.0
Total contribution	765.0
Total contribution with original constraint for labour	750.0
Shadow price of skilled labour, per minute	15.0

The shadow price of sales demand for Product is therefore 15 per unit of demand.

Shadow price of time on machine type 1 and machine type 2

In the optimal solution, the total available time on both machine type 1 and machine type 2 is not fully used. This means that there is spare capacity on both types of machine and the shadow price for both types of machine is $0.

5.3 Implications of shadow prices

An implication of shadow prices is that the value of the objective function (total contribution) could be increased if more units of the limiting factor could be made available. In the previous example:

- Total contribution could be increased by $30 per skilled labour hour if more hours of skilled labour could be obtained at its normal variable cost per hour.
- Total contribution would be increased even if extra hours of skilled labour could be made available at a cost above its normal variable cost, provided that the additional cost per hour was less than $30.
- For example, if skilled labour is paid $18 per hour, total contribution would be increased even if the company had to pay an overtime premium of 50% to get skilled employees to work some overtime. The overtime premium would be $9 per hour, so total contribution could still be increased by $21 (= $30 - $9) for each extra hour of overtime worked.

The point where the shadow price falls to $0

The shadow price of a limiting resource applies only to additional quantities of the resource for as long as it remains a limiting factor.

Eventually, if more and more units of a scarce resource are made available, a point will be reached when it ceases to be an effective limiting factor, and a different constraint becomes a limiting factor instead. When this point is reached, the shadow price for additional units of the resource will become $0.

In the above example, it is difficult to identify clearly where this point would be reached for skilled labour. As more and more hours of skilled labour are made available, the constraint line for skilled labour will move out from the origin of the graph, and skilled labour will cease to be a limiting factor when its constraint line moves beyond the point on the graph were the lines y = 20 and 40x + 45y = 1,800 intersect. (Workings are not shown.)

At this point:

(1)	y	=	20
(2)	40x + 45y	=	1,800
Multiply (1) by 45:			
(3)	45y	=	900
Subtract (3) from (2)	40x	=	900
	x	=	22.5

The skilled labour hours required to produce 20 units of y (Product C) and 22.5 units of x (Product B) would be (20 × 30) + (22.5 × 20) = 1,050 minutes per day.

The original constraint for skilled labour was 900 minutes per day.

The shadow price of $0.50 per minute or $30 per hour for skilled labour therefore applies only for an additional 150 minutes or 2.5 hours per day.

Summary: shadow prices

Important implications of shadow prices for management can be summarised as follows.

- Management need to be aware that for each limiting factor it might be profitable to acquire additional units of the limiting factor even if they cost more than the normal variable cost.
- However, it is also necessary to know the limit to the additional units of the scarce resource that would add to total contribution. Beyond this point, the shadow price of the resource falls to $0.
- Although it is assumed that the aim is always to maximise the value of the objective function (total contribution), non-financial considerations might influence the decision. For example if skilled labour is a limiting factor and management is considering whether to pay workers a premium to work overtime, non-financial factors could be:
  - The amount of premium paid for overtime working: if this is set at a high level, it might cause discontent amongst the rest of the work force
  - The number of overtime hours to be worked per employee. If individuals work excessive hours of overtime, they could get tired and the quality and efficiency of their work might decline.

5.4 Slack

Slack refers to the amount of a constraint that is not used in the optimal solution to a linear programming problem. In the previous example, there was slack for both machine type 1 and machine type 2, because the total available time was not fully used in the optimal solution.

In the original solution where x = 15 and y = 20, the total time required per day on machine type 1 was (15 × 30 minutes) + (20 × 10 minutes) = 650 minutes, and up to 900 minutes were available.

The total time required per day on machine type 2 was (15 × 40 minutes) + (20 × 45 minutes) = 1,500 minutes, and up to 1,800 minutes were available.

Implications of slack

When there is some slack, management should consider possible implications.

If there is some slack for a production resource, such as machine time, it might be worth considering whether a reduction in production capacity would be advisable. If the slack is long-term, there will be over-capacity in production. Machines might be sold off, or the spare capacity might be used for other purposes that might add to contribution and profit.

CHAPTER 4

Pricing decisions

Contents

Factors that influence price

- The nature of pricing decisions
- Demand and supply
- Cost
- Income of customers
- Product life cycle
- Quality
- Other factors influencing price

1 Factors that influence price

1.1 The nature of pricing decisions

For many companies, pricing decisions are amongst the most important decisions management must make. The selling price for a company's products or services will affect:

- the volume of sales demand, and
- the profit margin per unit.

Some pricing decisions are for the longer term; companies have to decide the general price level at which it wants to sell its goods or services. The ability of companies to decide the general level of selling prices differs according to the size of the company relative to the size of the market it operates in.

- Companies that dominate their market, and are the largest suppliers to the market, are often able to decide what selling prices should be. They are 'price makers'. Companies that dominate their market might sell their products at low prices to maintain their dominant market share.
- Companies that do not dominate their market are usually 'price takers', which means that they have to sell their products at about the same price as other companies in the market. They are unable to sell at lower prices without incurring a loss; and if they try selling at higher prices, customers will switch to rival suppliers.

In the short term companies might use other pricing strategies, such as temporary price reductions or pricing a special job or contract at a low price in order to win the work and a new customer.

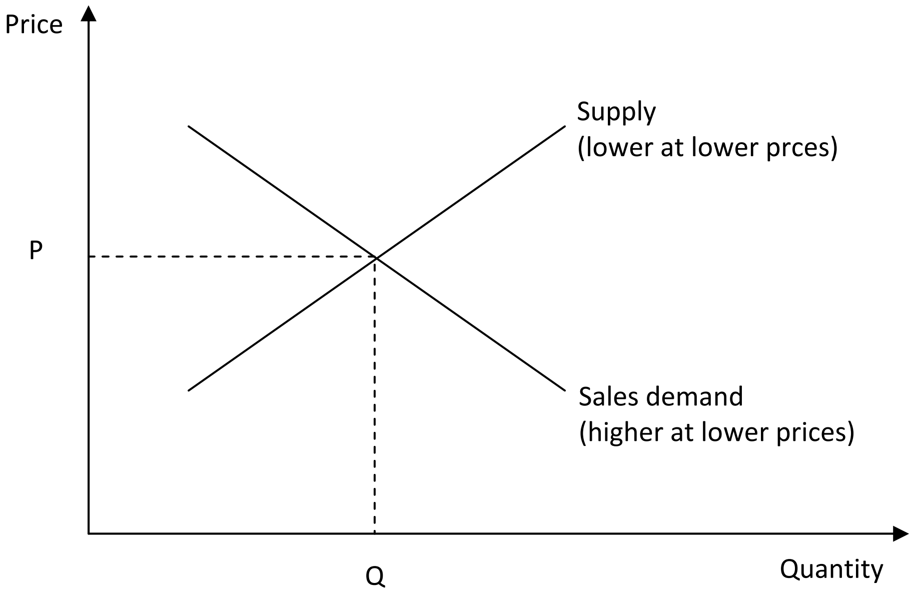
Some of the factors that influence sales pricing decisions are described briefly in the rest of this section.

1.2 Demand and supply

According to basic microeconomic analysis, the sales price for a product in a market is determined by demand and supply.

- Demand is the volume of sales demand that will exist for the product at any given price. As a normal rule, sales demand will be higher when the price is lower. If the price rises, total sales demand will fall. If the price falls, sales demand will rise.
- Supply is the quantity of the product (or service) that suppliers are willing to sell at any given sales price. Higher prices will attract more suppliers into the market and encourage existing suppliers to produce more. Lower prices will deter some suppliers, and might drive some out of business if the price fall results in losses.

A simple graph of supply and demand is shown below. In this diagram, the equilibrium price level is the sales price that would become established in the market if the factors that affect supply or demand did not change. Here the price would be $P and the total sales demand for the product would be Q units.



Occasionally, sales demand for a product might rise to such a high level that producers in the market are unable to meet the demand in full. Until production capacity can be increased, this situation could result in very large price rises and very high profit margins for producers.

An example of demand exceeding supply capacity has been the market for oil on occasions in the past. Oil suppliers are unable to alter their output volumes quickly, so a large increase in demand for oil can result in very large price increases, at least in the short term.

Monopoly pricing

Supply and demand in the diagram above is for the market as a whole, and within the market there might be many different suppliers competing with each other to win business.

A similar situation applies to companies that are dominant in their particular market, and supply most of the goods or services sold in the market. In these 'monopoly markets', the individual company has a downward-sloping demand curve, which means that:

- as a monopoly supplier to the market, it is in a position to set prices for the market, but
- if it raises the prices of its products, the demand for its products will fall.

Pricing in a competitive market

In contrast to a monopoly market, companies that sell their products in a highly competitive market will decide their selling prices by comparing them with those of competitors.

In order to compete effectively, companies might use short-term pricing tactics such as price reductions, volume purchase discounts, better credit terms and so on.

1.3 Cost

In the long run, the sales price must exceed the average cost of sales of the product that a business entity sells. If cost is higher than selling price, the business will make a loss and cannot survive in the long term. Cost is therefore a major determinant of price.

Costs are influenced by factors such as:

- suppliers' prices for raw materials and components
- price inflation
- exchange rate movements
- other elements of cost, such as wage rates and general expenses
- quality: it usually costs more to produce an item to a higher quality standard.

A company may have to decide where it wants to position its product in the market in terms of quality. Premium pricing (higher-than-average prices) prices can be used for higher quality products, but customers may prefer lower quality, lower priced products. A clear understanding of the link between quality and cost will be needed to help management determine the optimum price/quality mix.

If a company is able to reduce its costs, it should be in a position if it wishes to reduce its sales prices and compete more aggressively (on price) for a bigger share of the market.

1.4 Income of customers

Another microeconomic factor influencing sales demand in any market is the level of income of customers and potential customers for the product.

As the income of customers rises, they are more likely to want to buy more of the product. When demand is growing because income levels are rising, there is a tendency for prices to rise.

- In an economy as a whole, rising income occurs when the national economy is growing, and prices will rise. (The authorities might try to prevent excessive inflation, but prices will nevertheless increase.)

- When income in an economy is falling, there is an economic recession, and there might even be some price falls.

1.5 Product life cycle

The product life cycle was explained in an earlier chapter on life cycle costing. As a product goes through the different stages of its life cycle, sales prices will change.

- **Introduction stage**. During the introduction stage of its life cycle, the product is introduced to the market. If the product is new, and there are no rival products on the market, there is a choice between a market skimming policy for pricing or a market penetration policy. These policies are explained later.
- **Growth stage**. During the growth stage of the life cycle, demand for the product increases rapidly, but more competitors enter the market. If the market is competitive, each firm might have to lower its prices to win a share of the growing market. However, because sales demand is strong, prices and profit margins are likely to be fairly high (although falling). Some companies might try to identify a specialist 'niche' in the market, where they have more control over pricing of their products. Similarly, companies might try to keep prices higher by differentiating their product from those of competitors on the basis of quality or other distinguishing features (such as design differences).
- **Maturity stage**. When a product reaches the maturity stage of its life cycle, total sales demand in the market becomes stable, but the product may become a 'commodity'. Firms must then compete for market share, often by cutting prices. Companies might use product differentiation strategies to keep the price of their product higher than it might otherwise be, but prices generally will be lower than during the growth stage of the life cycle.
- **Decline**. Eventually, the market demand for a product declines. When sales demand falls, companies leave the market. Those that remain keep on selling the product as long as they can make a profit. Prices might remain very low. In some cases, however, a product might acquire 'rarity value', allowing companies to raise prices. However, since unit costs will also be higher, it is still difficult to make a profit.

1.6 Quality

Some customers will often be willing to pay more for better quality and companies may set prices higher than the market average because their products have a better-quality design or more features that provide value to customers.

Quality is often 'real', and can be provided by better-quality materials (for example in clothing products) or by greater reliability of performance or better performance (for example in motor cars).
Quality may also be 'perceived' rather than real, and customers will pay more for a branded product than for a similar or near-identical product with no brand name or a 'cheaper' brand name.

1.7 Other factors influencing price

There are other influences on pricing decisions and the general level of selling prices in a market.

- The price of 'substitute goods'. Substitute goods are goods that customers could buy as an alternative. Companies might set the price for their product in the knowledge that customers could switch to an alternative product if they think that the price is too high. For example, if the price of butter is too high, more customers might switch to margarine or other types of 'spread'.
- The price of 'complementary goods'. Complementary goods are items that customers will have to buy in addition to complement the product. The pricing of complementary products is explained in more detail later, as a pricing strategy that companies may use.
- Consumer tastes and fashion. High prices might be obtained for 'fashion goods'.
- Advertising and marketing. Sales demand can be affected by sales and marketing activities, including public relations activity. Strong consumer interest in a product or service could allow a company to set a higher price.

In addition to general factors influencing price, such as supply and demand, competition and cost, companies will use one or more different pricing strategies to decide the sales prices for their products or services.

A number of different pricing strategies are described in a later section of this chapter.

Price elasticity of demand

- Price elasticity of demand: its meaning and measurement
- Elastic and inelastic demand
- Elasticity and setting prices

2 Price elasticity of demand

2.1 Price elasticity of demand: its meaning and measurement

Within a market as a whole, there is an inverse relationship between selling price and sales demand. At higher prices, total sales demand for a product will be lower. For individual companies in a monopoly position in their market (or niche of the market) the same rule applies: if prices are raised, demand will fall.

The price elasticity of demand (PED) is a measurement of the change in sales demand that would occur for a given change in the selling price.

It is measured as:

$$\frac{\text{The change in quantity demanded as a percentage of original demand}}{\text{The change in sales price as a percentage of the original price}}$$

Price elasticity of demand has a negative value, because demand rises (positive) if the price falls (negative), and demand falls if the price rises.

Example

The following estimates have been made of total sales demand for product X:

- An increase in the price from $9 to $10 will result in a fall in daily demand from 2,000 to 1,600 units
- A fall in the price from $5 to $4 will result in a rise in daily demand from 8,000 to 9,000 units.

Required

Calculate the price elasticity of demand for product X at a price of:

(a) $9

(b) $5

a

Answer

(a) If the price is increased from \$9 to \$10

The change in quantity demanded as a percentage of original demand
= - 400/2,000 = - 0.20 or - 20%.

The change in price as a percentage of the original price = \$1/\$9 = + 0.111 or + 11.1%.

PED = - 0.20/ + 0.111 = - 1.8.

(b) If price is reduced from \$5 to \$4

The change in quantity demanded as a percentage of original demand
= + 1,000/8,000 = + 0.125 or + 12.5%.

The change in price as a percentage of the original price = - \$1/\$5 = - 0.20.

PED = + 0.125/- 0.20 = - 0.625.

2.2 Elastic and inelastic demand

Sales demand for a product could be either elastic or inelastic in response to changes in sales price.

- Demand is elastic if its value is above 1. (More accurately, demand is elastic if its elasticity is a figure larger than – 1.)
- Demand is inelastic if its value is less than 1. (More accurately, demand is inelastic if its elasticity is a figure below – 1, between 0 and – 1.)

The significance of elasticity

Price elasticity of demand affects the amount by which total sales revenue from a product will change when there is a change in the sales price.

If demand is highly elastic (greater than 1, ignoring the minus sign):

- increasing the sales price will lead to a fall in total sales revenue, due to a large fall in sales demand, and
- a reduction in the sales price will result in an increase in total sales revenue, due to the large rise in sales demand.

Profit might increase or decrease when the sales price is changed, depending on changes in total costs as well as the change in total revenue.

If demand is inelastic (less than 1, ignoring the minus sign):

- increasing the sales price will result in an increase in total sales revenue from the product, because the fall in sales volume is fairly small, and

- reducing the sales price will result in lower total sales revenue, because the increase in sales demand will not be enough to offset the effect on revenue of the fall in price.

A product does not necessarily have high or low price elasticity of demand at all price levels. The same product might have a high price elasticity of demand at some sales prices and low price elasticity at other prices.

2.3 Elasticity and setting prices

An understanding of the price elasticity of demand for products can help managers to make pricing decisions:

- If demand is inelastic, raising selling prices will result in higher sales revenue. Since fewer units will be sold, it should be expected that total costs will fall. Higher revenue and lower total costs mean higher profits. If management believe that sales demand for their product is price-inelastic, they might therefore consider raising the sales price.
- If demand is inelastic, reducing the sale price will lead to lower total sales revenue. Sales demand will increase, and so the costs of sales are also likely to increase. Profits are therefore likely to fall.
- If demand is elastic, an increase in the sales price will lead to a fall in total sales revenue. Sales demand will also fall. If managers are thinking about an increase in the sales price, they will have to consider whether the fall in total costs (due to the lower volume of sales) will exceed the fall in total revenue.
- If demand is elastic, reducing the sales price will increase total sales revenue from the product, but total sales volume will increase. The effect, as with raising sales prices for a product with high price elasticity of demand, could be either higher or lower total profits. There is a risk that if one company reduces its sales prices and elasticity of demand is high, this could lead to a 'price war' in which all competitors reduce their prices too. At the end of a price war, all sellers are likely to be worse off.

Companies might try to reduce the price elasticity of demand for their products by using non-price methods, such as improving product quality, improving service and the use of advertising and sales promotions.

Demand equations, cost functions and maximising profit

- Straight-line demand equation
- Total cost function
- Maximising profit
- Problems using a demand equation
- Incremental revenue and incremental cost

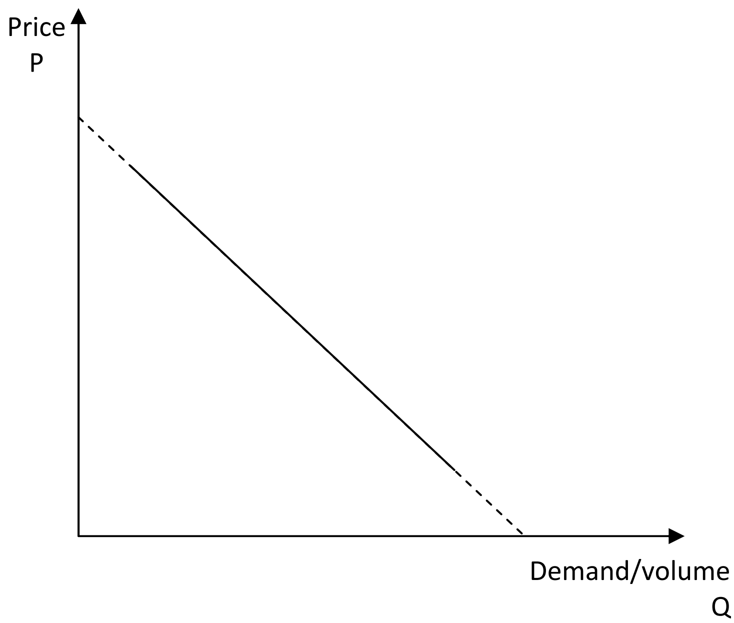
3 Demand equations, cost functions and maximising profit

If a demand equation and a cost function can be obtained for a product, it will be possible to calculate the sales price and sales volume) at which profit would be maximised.

3.1 Straight-line demand equation

A demand equation is an equation for the relationship between total sales demand for a product and the selling price. If a demand equation is drawn on a graph, with price on the y axis and sales demand/volume on the x axis, the equation would slope down from left to right.

For the purpose of the F5 examination, only straight-line demand equations are examinable. A straight-line demand equation would be shown on a graph as follows:



In reality a demand equation is unlikely to be accurate at very high levels of price or very low levels of sales demand. This is why the demand equation in this diagram is shown with a dotted line at each end.

Deriving a demand equation

A demand equation expresses the relationship between sales price and sales demand at all price levels. A straight-line demand equation has the basic formula.

$P = a - bQ$

where

P = the sales price
Q = the quantity demanded at that price
a = the sales price when the quantity demanded is 0
b = a constant value, representing the amount of change in sales demand for a given change in the sales price.

For example, the demand equation for a product might be:

$P = 12 - 0.0001Q$

This demand equation means that:

- At a selling price of \$12, sales demand would be 0
- For every \$1 reduction in the sales price, the sales demand would increase by 1/0.0001 = 10,000 units.

If the sales price is \$9, sales demand would therefore be 30,000 units, calculated as follows:
$P = 12 - 0.0001Q$
$9 = 12 - 0.0001Q$
$0.0001Q = 3$
$Q = 30,000$.

Example

The sales demand equation for a product is straight-line. When the sales price is \$40, sales demand is 0 units. For every \$0.50 increase in price, the sales demand falls by 1,000 units.

The demand equation is therefore:

$P = 40 - (0.50/1,000)Q$
$P = 40 - 0.0005Q$

Note

For every \$0.50 increase in price, sales demand changes by 1,000 units; therefore b in the formula is 0.50/1,000 = 0.0005.

3.2 Total cost function

A total cost function is an equation for total costs. When total costs are a combination of variable costs and fixed costs, a total cost function can be stated as:
$C = a + bQ$

where
a = total fixed costs
b = variable cost per unit
Q = volume of production and sales

3.3 Maximising profit

The demand equation and total cost function for a product can be used to calculate the sales price (and sales volume) at which total profits would be maximised.

- The demand equation can be used to calculate marginal revenue (MR).
- The total cost function can be used to calculate marginal cost (MC).
- Profit is maximised at the price and sales volume where marginal revenue equals marginal cost:

  In other words, **profit is maximised where MR = MC.**

Calculating marginal revenue (MR)

The marginal revenue is the change in total sales revenue that would occur if one extra unit of the product is sold. If the sales price is constant, the marginal revenue per unit is its sales price. However, when there is a downward-sloping demand equation for a product, one extra unit of product can be sold only by reducing the sales price **for all units** of the product that are sold.

- Marginal revenue is therefore less than the sales price.
- The marginal revenue will continue to fall as the sales price falls and sales demand increases.

To obtain a formula for calculating marginal revenue, the demand equation must be converted into an equation for total revenue.

(1) Total revenue = Price × Quantity

(2) The price is represented by the demand equation, $P = a - bQ$

Substituting (2) in (1), we get:

(3) Total revenue = $(a - bQ)\,Q$, $= aQ - bQ^2$

The formula for calculating marginal revenue is obtained by applying differential calculus to the formula for total revenue. If you are not familiar with differential calculus, you should learn the following technique:

(1) If total revenue (TR) = $aQ - bQ^2$

(2) Marginal revenue (MR) = $a - [2b \times Q]$

Example

Returning to the previous example: The demand curve is $P = 40 – 0.0005Q$

Therefore the formula for total revenue is:

$TR = (40 – 0.0005Q)\ Q = 40Q – 0.0005Q^2$

Therefore the formula for marginal revenue is

$MR = 40 – (2 \times 0.0005)\ Q = 40 – 0.001Q$.

Calculating marginal cost (MC)

The marginal cost per unit is the additional cost of making and selling one extra unit of the product. It can be obtained by applying differential calculus to the total cost function.

However when the total cost function is a liner cost function $TC = a + bQ$, the marginal cost per unit is its variable cost (b).

Profit-maximisation, MR = MC

Profit will be maximised at the sales price (and volume) where MR = MC.

Example

Suppose that the monthly demand equation for a product is $P = 40 – 0.0005Q$. Fixed costs per month are \$500,000 and the variable cost per unit is \$2.

Required

Calculate the sales price and output quantity that maximise the profit each month, and calculate the amount of that profit.

Answer

The marginal revenue for this demand equation was calculated earlier:
$MR = 40 – 0.001Q$
$MC = 2$

Profit is maximised when MR = MC
$40 – 0.001Q = 2$
$0.001Q = 38$
$Q = 38{,}000$ units.

The sales price when Q = 38,000 is:
$P = 40 – 0.0005(38{,}000) = \$21$.
Profit is therefore maximised at a sales price of \$21.

	$
Sales (38,000 × $21)	798,000
Variable costs (38,000 × $2)	76,000
Contribution	722,000
Fixed costs	500,000
Profit	222,000

e

Example

A company is the monopoly producer of Product T. The product is currently sold at a price of $16 and annual sales demand at this price is 80,000 units. Total annual fixed costs are $750,000 and variable costs are $5 per unit.

It has been estimated that if the sales price is increased, sales demand would fall by 2,500 units for every $1 increase in price. Similarly, if the sales price is reduced, demand would increase by 2,500 units for every $1 reduction in the price.

Required

(a) Calculate the annual profit at the current sales price.

(b) Calculate the sales price and output quantity that maximise the annual profit, and calculate the amount of that profit.

a

Answer

At current price of $12	$
Sales (80,000 × $16)	1,280,000
Variable costs (80,000 × $5)	400,000
Contribution	880,000
Fixed costs	750,000
Profit	130,000

We need to derive the demand equation. To do this, we need to calculate the sales price at which demand Q would be 0 units.
At the moment, demand is 80,000 units when the sales price is $16, and demand will fall by 2,500 units for every $1 increase in the price. Total sales demand will therefore be 0 units at a price of:
$18 + $(80,000/2,500) = $18 + $32 = $50.

The demand equation is therefore: $P = 50 - (1/2,500)Q$
$= 50 - 0.0004Q$

Total revenue = $P \times Q$
$= (50 - 0.0004Q) \times Q = 50Q - 0.0004Q^2$

Marginal revenue $MR = 50 - (2 \times 0.004)$
$= 50 - 0.0008Q$ Q

MC = 5

Profit is maximised when MR = MC
50 – 0.0008Q = 5
0.0008Q = 45
Q = 56,250 units.

The sales price when Q = 56,250 is:
P = 50 – 0.0004(56,250) = $27.5.
Profit is therefore maximised at a sales price of $27.50.

Maximum profit	$
Sales (56,250 × $27.50)	1,546,875
Variable costs (56,250 × $5)	281,250
Contribution	1,265,625
Fixed costs	750,000
Profit	515,625

3.4 Problems using a demand equation

There are several practical difficulties with using a demand equation to establish a profit-maximising price.

- There may be insufficient reliable data to produce an estimate of the demand equation.
- The assumption that the demand equation is a straight line may be inaccurate.
- A demand equation normally applies to either total market demand for a product or to the demand for a product that is made and sold by a company in a monopoly position in its market. For smaller companies in a competitive market, selling prices might not be the profit-maximising price, but a price at which the company can compete successfully against its rivals.

3.5 Incremental revenue and incremental cost

Because of the practical problems with deriving a reliable demand equation, decisions about changing the selling price for a product are more likely to be assessed by comparing the incremental revenues and incremental costs that would arise from the price change.

Reducing the selling price of a product by a specific amount should be expected to result in higher sales demand. (If it doesn't, there would be no reason to reduce the price.) Higher sales demand would be met by increasing the volume of output; and at higher volumes of output, costs will change.

- The may be no change in variable costs; however variable costs per unit may change. Labour costs per hour will increase if employees are required to work overtime to produce the higher volume of output. On the other hand, direct materials costs per unit might change if volume purchase discounts are available at the new volume of production.

- There may be no change in fixed cost expenditure; however fixed cost spending may be higher at higher volumes of output due to a 'step' increase in fixed costs.

To assess the effect of a proposed increase in price on profit, it is necessary to calculate:

- the incremental sales revenue, which is the increase in total sales revenue that would occur (or fall in total revenue, if demand is inelastic), and
- the incremental costs, which is the net increase in total costs, both fixed and variable that would occur.

A reduction in price would be justified if incremental revenue exceeded incremental costs.

Study the following example carefully.

Example

A company makes and sells a single product. The sales price is $20 per unit. Annual sales demand is currently 24,000. Annual fixed costs are $250,000, and the variable cost per unit is $8, made up as follows:

Variable cost per unit	$
Materials	4
Direct labour	3
Other variable costs	1
Total variable cost	8

The company is considering a proposal to reduce the sales price from $20 to $19. At the lower price, it is expected that annual sales demand would be 30,000 units. The following changes in costs would occur if annual production and sales are increased to 30,000 units:

A favourable volume price discount would be obtained on direct material purchases, and materials costs would fall by 10% for all units produced by the company during the year.

The company's output capacity is 28,000 units during normal working time. At output volumes above this amount, some overtime would have to be worked. The overtime premium is 50% on top of normal hourly rates of pay.

Total fixed cost expenditure would increase to $260,000.

Required

(a) Calculate the effect on annual profit of the proposed price reduction and recommend (on the basis of change in profit) whether the price should be reduced.

(b) Briefly state any other factors, other than profitability, that might influence the pricing decision.

a

Answer

	$	$
Sales revenue at new price level: 30,000 × $19		570,000
Sales revenue at current price level: 24,000 × $20		480,000
Incremental revenue		90,000
Total materials cost at new price level: 30,000 × $4 × 90%	108,000	
Total materials cost at current price level: 24,000 × $4	96,000	
Incremental cost of materials		(12,000)
Incremental cost of labour at basic rate of pay: 6,000 units × $3	18,000	
Overtime premium for 2,000 units: 2,000 × $3 × 50%	3,000	
Total incrmeental cos tof labour		(21,000)
Other variable costs: incremental costs: 6,000 units × $1		(6,000)
Incremental fixed cost expenditure $(260,000 – 250,000)		(10,000)
Incremental profit		41,000

Conclusion: By reducing the price to $19, annual profits would increase by $41,000. On the basis of profitability, the sales price should be reduced.

Other factors could affect the decision:

- Profit might be increased even more if the sales price is changed to a different amount, say $18.
- Management needs to be satisfied that the company has the capacity to produce the larger volume of output without loss of production efficiency or quality.
- The recommendation that the price should be reduced assumes that the estimate of sales demand at $19 per unit is reliable. If competitors respond by reducing their prices by a similar amount, there might be little or no sales volume increase, and profits might fall rather than increase.

Price strategies

- The nature of pricing strategies
- Full cost plus pricing
- Marginal cost plus pricing (mark-up pricing)
- Return on investment (ROI) pricing
- Market skimming prices
- Market penetration prices
- Pricing of complementary products and product line pricing
- Volume discounting
- Price discrimination
- Relevant cost pricing (minimum pricing)

4 Price strategies

4.1 The nature of pricing strategies

Although sales prices in a market are determined largely by factors such as supply and demand and competition, companies might use a variety of different pricing strategies, depending on the nature of their business, the nature of the markets in which they operate and the particular circumstances in which a pricing decision is made. For example:
For companies in a jobbing industry or contracting industry, each new job or contract might be different, and this means that a separate price has to be calculated for each individual job or contract. Some form of cost-plus pricing is therefore often used in these industries.
When a company brings an entirely new product to the market, can decide whether to set the price high or low, because there are no rival products on the market.

Several different pricing strategies are described in this section.

4.2 Full cost plus pricing

Full cost plus pricing involves calculating the full cost of an item (such as a job or contract) – or the expected full cost – and adding a profit margin to arrive at a selling price.

Profit is expressed as either:

- a percentage of the full cost (a profit 'mark-up') or
- a percentage of the sales price (a 'profit margin').

In the following example, the profit on full cost is a mark-up of 25% on full cost, which gives a profit margin of 20% on the sales price.

	$
Variable production costs	600
Other variable costs	200
Absorbed overheads:	
Production overheads absorbed	800
Non-production overheads absorbed	300
Full cost	1,900
Profit (added to full cost)	475
Selling price	2,375

Notes on calculating the profit:

- If the mark-up is x% of full cost, the selling price is Full cost + x%. In this example there is a mark-up of 25% on full cost, and since the full cost is $1,900, the profit is (25%) $475, giving a sales price of $2,375.
- If the profit margin is y% of the sales price, the sales price is calculated as Full cost × profit is [y/(100 – y)] × Full cost. In this example, the profit margin is 20% of the sales price and the full cost is $1,900: therefore the sales price is $1,900 × 100/(100 – 20) = $2,375.

Advantages of full cost plus pricing

A business entity might have an idea of the percentage profit margin it would like to earn on the goods or services that it sells. It might therefore decide the average profit mark-up on cost that it would like to earn from sales, as a general guideline for its pricing decisions. This can be useful for businesses that carry out a large amount of **contract work** or **jobbing work**, for which individual job or contract prices must be quoted regularly to prospective customers and there is no obvious 'fair market' price.

The percentage mark-up or profit margin does not have to be a fixed percentage figure. It can be varied to suit the circumstances, such as demand conditions in the market and what the customer is prepared to pay.

There are also other possible advantages in using full cost plus pricing:

- If the budgeted sales volume is achieved, sales revenue will cover all costs and there will be a profit.
- It is useful for justifying price rises to customers, when an increase in price occurs as a consequence of an increase in costs.

Disadvantages of full cost plus pricing

The main disadvantage of cost plus pricing is that it is calculated on the basis of cost, without any consideration of market conditions, such as competitors' prices.

- Cost plus pricing fails to allow for the fact that when the sales demand for a product is affected by its selling price, there is a profit-maximising combination of price and demand. A cost plus based approach to pricing is unlikely to arrive at the profit-maximising price for the product.

- In most markets, prices must be adjusted to market and demand conditions. The pricing decision cannot be made on a cost basis only.

There are also other disadvantages:

- The choice of profit margin or mark-up is arbitrary. How is it decided?
- When a company makes and sells different types of products, the calculation of a full cost becomes a problem due to the weaknesses of absorption costing. The method of apportioning costs between the different products in absorption costing is largely subjective. This affects the calculation of full cost and the selling price. For example, full cost per unit will differ according to whether a direct labour hour absorption rate or a machine hour absorption rate is used. Full cost will also differ if activity-based costing is used.

Example

Entity Q makes two products, product X and product Y. These products are both made by the same work force and in the same department. The budgeted fixed costs are $900,000. Variable costs per unit are as follows:

		Product X		Product Y
Direct costs		$		$
Materials		6		6
Labour	(2 hours)	12	(3 hours)	18
Expenses	(1 machine hour)	6	(1 machine hour)	6
		24		30

Budgeted production and sales are 15,000 units of product X and 10,000 units of product Y.

Required

Calculate the sale prices for each unit of product X and product Y which give a profit margin of 20% on the full cost, if overheads are absorbed on the following bases:

(a) on a direct labour hour basis

(b) on a machine hour basis.

Answer

(a) **Direct labour hour basis**

Budgeted direct labour hours = (15,000 × 2) + (10,000 × 3) = 60,000 hours.

Overhead absorption rate = $900,000/60,000 = $15 per direct labour hour.

	Product X	Product Y
Direct costs	$	$
Materials	6.00	6
Labour	12.00	18
Expenses	6.00	6
	24.00	30
Absorbed overhead	30.00	45
Full cost	54.00	75
Mark-up (20%)	10.80	15
Selling price/unit	64.80	90

The budgeted profit would be (15,000 × $10.80) + (10,000 × $15) = $312,000.

(b) **Machine hour basis**

Budgeted machine hours = (15,000 × 1) + (10,000 × 1) = 25,000 hours.

Overhead absorption rate = $900,000/25,000 = $36 per machine hour.

	Product X	Product Y
Direct costs	$	$
Materials	6.00	6.00
Labour	12.00	18.00
Expenses	6.00	6.00
	24.00	30.00
Absorbed overhead	36.00	36.00
Full cost	60.00	66.00
Mark-up (20%)	12.00	13.20
Selling price/unit	72.00	79.20

The budgeted profit would be (15,000 × $12) + (10,000 × $13.20) = $312,000.

However, the different bases of absorbing overheads would give a significantly different full cost for each product, and a different selling price. It is doubtful whether the entity can sell 15,000 units of product X and 10,000 units of product Y, no matter which prices are chosen.

4.3 Marginal cost plus pricing (mark-up pricing)

With marginal cost plus pricing, also called mark-up pricing, a mark-up or profit margin is added to the marginal cost in order to obtain a selling price.

	$
Variable production costs	600
Other variable costs	200
Marginal cost	800
Mark-up (added to marginal cost)	400
Selling price	1,200

The method of calculating sales price is similar to full-cost pricing, except that marginal cost is used instead of full cost. The mark-up represents contribution.

Advantages of marginal cost plus pricing

The advantages of a marginal cost plus approach are as follows:

- It is useful in some industries such as retailing, where prices might be set by adding a mark-up to the purchase cost of items bought for resale. The size of the mark-up can be varied to reflect demand conditions. For example, in a competitive market, a lower mark-up might be added to high-volume items.
- It draws management attention to contribution and the effects of higher or lower sales volumes on profit. This can be particularly useful for short-term pricing decisions, such as pricing decisions for a market penetration policy (described later).
- When an organisation has spare capacity, marginal cost plus pricing can be used in the short-term to set a price which covers variable cost. This approach is used by hotels, airlines, railway companies and telephone companies **to price off-peak usage**. As long as fixed costs are covered by peak users and the lower price set does not affect the main market, a marginal cost price can be set off-peak to increase demand and therefore contribution.
- It is more appropriate where fixed costs are low and variable costs are high.

Disadvantages of marginal cost plus pricing

A marginal cost plus approach to pricing also has disadvantages.

- Although the size of the mark-up can be varied according to demand conditions, marginal cost plus pricing is a cost-based pricing method, and does not properly take market conditions into consideration.
- It ignores fixed overheads in the pricing decision. Prices must be high enough to make a profit after covering all fixed costs. Cost-based pricing decisions therefore cannot ignore fixed costs altogether. A risk with marginal cost plus pricing is that the mark-up on marginal cost might not be sufficient to cover fixed costs and achieve a profit.

4.4 Return on investment (ROI) pricing

This method of pricing might be used in a decentralised environment where an investment centre within a company is required to meet a target return on capital employed. Prices might be set to achieve a target percentage return on the capital invested.
With return on investment pricing, the selling price per unit may be calculated as:

$$\frac{\text{Budgeted total costs of the division} + [\text{Target ROI\%} \times \text{Capital employed}]}{\text{Budgeted volume}}$$

- When the investment centre makes and sells a single product, the budgeted volume is sales volume.
- When the investment centre makes and sells several different products, budgeted volume might be production volume in hours, and the mark-up added to cost is then a mark-up for the number of hours worked on the product item.
- Alternatively, the budgeted volume might be sales revenue, and the mark-up is then calculated as a percentage of the selling price (a form of full cost plus pricing).

Advantages of ROI pricing

The advantages of an ROI approach to pricing are as follows:

- ROI pricing is a method of deciding an appropriate profit margin for cost plus pricing.
- The target ROI can be varied to allow for differing levels of business risk.

Disadvantages of ROI pricing

An ROI approach to pricing also has disadvantages.

- Like all cost-based pricing methods, it does not take market conditions into sufficient consideration, and the prices that customers will be willing to pay.
- Since it is a form of full cost plus pricing, it shares most of the other disadvantages as full cost plus pricing.

Example

A manufacturer is about to launch a new product.

The non-current assets needed for production will cost $4,000,000 and working capital requirements are estimated at $800,000.

The expected annual sales volume is 40,000 units.

Variable production costs are $60 per unit.

Fixed production costs will be $600,000 each year and annual fixed non-production costs will be $200,000.

Required

(a) Calculate selling price using:

(i) full cost plus 20%

(ii) marginal cost plus 40 %

(iii) pricing based on a target return on investment of 10% per year.

(b) If actual sales are only 20,000 units and the selling price is set at full cost plus 20%, what will the profit be for the year?

a

Answer

(a)

(i) Full cost plus 20%	**$ per unit**
Variable cost	60
Fixed costs ($600,000 + $200,000)/40,000 units	20
Full cost	80
Mark-up: 20% on cost	16
Selling price	96

(ii) Marginal cost plus 40%	**$ per unit**
Variable cost	60
Mark-up: 40% on variable cost	24
Selling price	84

(iii) Target ROI pricing	**$**
Non-current assets	4,000,000
Working capital	800,000
Capital employed	4,800,000
Profit required ($4,800,000 × 10%)	480,000
Profit required per unit (40,000 units)	$12

	$
Variable cost	60
Fixed costs (see above, full cost plus pricing)	20
Full cost	80
Profit	12
Selling price	92

(b) If sales are only 20,000 units (= below budget):

Profit for the year	**$**
Sales (20,000 units × $96)	1,920,000
Variable costs (20,000 units × $60)	(1,200,000)
Fixed costs	(800,000)
Net loss	(80,000)

4.5 Market skimming prices

When a company introduces a new product to the market for the first time, it might choose a pricing policy based on 'skimming the market'.

When a new product is introduced to the market, a few customers might be prepared to pay a high price to obtain the product, in order to be one of the first people to have it. Buying the new product gives the buyer prestige, so the buyer will pay a high price to get it.

In order to increase sales demand, the price must be gradually reduced, but with a skimming policy, the price is reduced slowly and by small amounts each time. The contribution per unit with a skimming policy is very high, although unit costs of production could also be quite high, since sales volumes are low.

To charge high prices, the firm might have to spend heavily on advertising and other marketing expenditure.

Market skimming will probably be more effective for new 'high technology' products, such as (in the past) flat screen televisions and laptop computers.

Firms using market skimming for a new product will have to reduce prices later as new competitors enter market with rival products. A skimming strategy is therefore a short-term pricing strategy that cannot usually be sustained for a long period of time.

Skimming prices and a product differentiation strategy

It is much more difficult to apply a market skimming pricing policy when competitors have already introduced a rival product to the market. Customers in the market will already have a view of the prices to expect, and might not be persuaded to buy a new version of a product in the market unless its price is lower than prices of existing versions.

However, it may be possible to have a policy of market skimming if it is possible to differentiate a new product from its rivals, usually on the basis of quality. This is commonly found in the market for cars, for example, where some manufacturers succeed in presenting new products as high-quality models. High-quality cars cost more to produce, and sales demand may be fairly low: however, profits are obtained by charging high prices and earning a high contribution for each unit sold.

4.6 Market penetration prices

Market penetration pricing is an alternative pricing policy to market skimming, when a new product is launched on to the market for the first time.

With market penetration pricing, the aim is to set a low selling price for the new product, in order to create a high sales demand as quickly as possible. With a successful penetration pricing strategy, a company might 'capture the market' before competitors can introduce rival products.

A firm might also use market penetration prices to launch its own version of a product into an established market, with the intention that offering low prices will attract customers and win a substantial share of the market.

Penetration pricing and a cost leadership strategy

A cost leadership market strategy is a strategy of trying to become the lowest-cost producer of a product in the market. Low-cost production is usually achieved through economies of scale and large-scale production and sales volumes.

Penetration pricing is consistent with a cost leadership strategy, because low prices help a company to obtain a large market share, and a large market share means high volumes, economies of scale and lower costs.

4.7 Pricing of complementary products and product line pricing

Complementary products

Complementary products are products that 'go together', so that if customers buy one of the products, they are also likely to buy the other. Examples of complementary products are:

- computer games consoles and computer games
- mobile telephones (portable phones) and telephone calls from mobile phones.

Occasionally if a company sells two or more complementary products it could sell one product at a very low price in the knowledge that if sales demand for the first product is high, customers will then buy more of the second product (which can be priced to provide a much bigger profit margin).

This price strategy has been used by some companies in mobile telephones. Telephones have been offered at low prices to customers, in the knowledge that customers will then use their phones to make expensive telephone calls. Losses on selling phones can therefore be offset by high profits on the phone calls.

Product lines

A product line is a range of products made by the same manufacturer (or a range of services from the same service provider) where the products have some similarity or connection so that customers see them as belonging to the same 'family'.

Examples of a product line are:

- a brand and design of tableware manufactured by the same company (such as a range of tableware items in Dresden china)
- a brand and range of sports items (such as rackets or golf equipment) made by the same manufacturer.

When manufacturers produce a line of related items, the pricing strategy for all items in the product line might be the same (for example, a product line might be sold as a high-price, high-quality branded range).

4.8 Volume discounting

A price strategy of volume discounting involves selling at reduced prices to customers who buy in large volumes over a period of time, or for large-value sales orders.

Volume discounting can have either of the following purposes:

- To persuade customers to buy a product, by offering a lower price (on condition that the order is above a given size)
- To increase profits by selling in larger volumes, even though the sales price is lower.

4.9 Price discrimination (differential pricing)

With price discrimination (or differential pricing), a firm sells a single identical product in different segments of the market at different prices.

A market segment is simply a separately-identifiable part of the entire market. Customers in one market segment have different characteristics, buying habits, preferences and needs from the customers in other segments of the same total market.

For price discrimination to work successfully, the different market segments must be kept separate. It might be possible to charge different prices for the same product:

- in different geographical areas – for example, it would be possible to sell the same product at very different prices in the US and in China
- at different times of the day – for example, travel tickets might be priced differently at different times of the day or the week
- to customers in different age groups – for example, offering special prices to individuals over a certain age, or to students or to children.

4.10 Relevant cost pricing (minimum pricing)

Relevant cost pricing may be used for pricing a product or a service in special circumstances. In some circumstances, an entity might be prepared to charge a price for an item that leaves it no worse off than if it were to choose the next most profitable course of action. This is the marginal price or **minimum price** of an item. A minimum price of an item is the total of the **relevant costs** of making and selling it.

Alternatively, a company might calculate the relevant cost of selling an item to a customer, and then set the sales price at an amount that will provide an incremental profit (incremental profit = actual sales price minus relevant cost price).

Relevant costs are explained more fully in a later chapter on decision-making. (You may have learned about them already in your previous studies.) Briefly, relevant costs are the future cash flows arising as a direct consequence of a decision. Relevant costs can be either:

- additional costs (cash flows), or
- the loss of contribution or profit that would occur as a result of taking a particular course of action.

In the context of deciding a sales price for a product or contract, a relevant cost price is the total of the relevant costs that would be incurred as a consequence of making and selling the item that is being priced.

Relevant costs include opportunity costs. **Opportunity costs** arise when a resource is in scarce supply (a limiting factor), and making and selling the item would require the use of some of the scarce resource. The relevant cost of the scarce resource is therefore the sum of:

- its variable cost, and
- the contribution that would be lost by using the resource to make and sell the product, instead o fusing it in the most profitable alternative way.

e

Example

Bota is a shipbuilding company. It uses two materials, steel and fibreglass.

It needs to complete a shipping order using 500 tonnes of steel and 1,000 tonnes of fibreglass.

The work force will have to work 2,000 hours on making the boat: 1,200 hours will be in the assembly process and the remainder will be in the finishing process (painting the boat and other finishing tasks).

Bota will charge a sales price of relevant cost plus 50%.

Bota has 200 tonnes of steel held in inventory. This originally cost $20 per tonne. Steel now has a current market price of $24 and the inventory could be sold for $16 per tonne. Bota no longer produces steel boats and has no other use for steel. It only produces fibreglass boats on a regular basis.

There are 400 tonnes of fibreglass held in inventory. This originally cost $40 per tonne. It currently has a purchase price of $46 per tonne and a selling price of $30 per tonne. (Selling price and net realisable value can be assumed to be the same figure).

All labour is paid $8 per hour and is treated as a variable cost. To complete the contract on time, labour for the finishing process will have to be transferred from other work which produces contribution at a rate of $6 per hour. There is currently surplus capacity for assembly labour amounting to 1,000 hours for the duration of the contract: if this time is not used on assembly work for this contract, it will be paid for as idle time. Owing to other work requirements, however, any further assembly labour hours in excess of these 1,000 hours will have to be hired on a temporary basis at a rate of $10 per hour.

Required

Calculate the price that Bota will quote on the contract.

Answer

		$
Steel		
Inventory already held	200 tonnes: opportunity cost = realisable value $16 per tonne	3,200
Additional purchases required	300 tonnes × $24 per tonne	7,200
Fibreglass	1,000 tonnes × $46 per tonne	46,000
	Existing inventory could be used on other jobs; therefore the relevant cost is the current market purchase price	
Assembly labour	200 hours × $10 per hour	2,000
	The cost of the other 1,000 hours wil lbe paid anyway as idle time, and so is not a relevant cost	
Finishing labour	Variable cost 800 hours × $8 per hour	6,400
	Opportunity cost: contribution lost by switching from other work: 800 hours × $6 per hour	4,800
Relevant cost		69,600
Mark-up (50%)		34,800
Quoted price		104,400

CHAPTER 6

Decision-making with risk and uncertainty

Contents

Risk and uncertainty

- The nature of risk and uncertainty
- Reducing uncertainty
- Dealing with risk and uncertainty in decision-making
- Risk preference

1 Risk and uncertainty

1.1 The nature of risk and uncertainty

A lot of decision-making in business involves some risk or uncertainty. Decisions might be based on what the decision-maker thinks will happen, but there is some possibility that the actual outcome will be different – possibly better or possibly worse than expected.

- **Uncertainty** occurs when there is insufficient information about what will happen, or what will probably happen, in the future. It is therefore likely that estimates of future values (estimates of future sales, future costs, and so on) will be inaccurate.
- **Risk** occurs when the future outcome from a decision could be any of several different possibilities. However, it might be possible to assess with reasonable accuracy the probability of each possible outcome. When there are reliable estimates of the probability for each possible outcome, risk can be assessed or analysed statistically.

1.2 Reducing uncertainty

Uncertainty occurs when there is a lack of reliable information. It can therefore be reduced by obtaining more information on which some reliance can be placed. However, it is doubtful whether uncertainty can be eliminated altogether.

There is often uncertainty about the likely volume of sales demand for a product.

- For established products, it might be possible to estimate future sales by taking historical sales figures, and making adjustments for sales growth or decline, and planned changes is the sales price.
- For new products, however, estimating sales demand can be very difficult because there is no benchmark on which to base the estimate.

Uncertainty about future sales demand for a product can be reduced through the use of market research or focus groups.

Market research is research into a particular market, such as the market for a product, for the purpose of obtaining information about the market – such as attitudes and buying intentions of customers in the market.

- Market research might be carried out, for example, to test the attitudes of target customers to a prototype of a new product.

- In some cases, market research might attempt to obtain an estimate of the likely sales demand for a product.

A focus group is a group of participants who are invited to give their views, opinions and ideas about a product or market to a market research team. The members of a focus group will be selected so as to represent a target audience or target market, and the information provided by the group will therefore be representative of the views of the target market as a whole.

By analysing data obtained from market research surveys or focus groups, an entity might expect to obtain more reliable estimates of the likely sales demand for a product.

1.3 Dealing with risk and uncertainty in decision-making

When there is uncertainty or risk in a business decision, management should consider both:

- the expected incremental costs, revenues and profits, and also
- the risk or uncertainty.

There are several different ways of allowing for risk and uncertainty in decision-making. The approach taken by management will depend to a large extent on their attitude to risk. In other words, to what extent will a management decision be affected by the risk or uncertainty in the situation?

Risk cannot be removed from a decision, because risk exists in the situation itself. A decision-maker can try to analyse the risk, and must make a decision on the basis of whether the risk is justified or acceptable.

1.4 Risk preference

Risk preference describes the attitude of a decision-maker towards risk. Decision-makers might be described as risk averse, risk-seeking or possibly risk neutral.

- A **risk averse decision maker** considers risk in making a decision, and will not select a course of action that is more risky unless the expected return is higher and so justifies the extra risk. A risk-averse decision maker does not try to avoid risk as much as possible; however he might want a substantially higher expected return to make any extra risk worth taking.
- A **risk neutral decision maker** ignores risk entirely in making a decision. The decision of a risk neutral decision maker is to select the course of action with the highest expected return, regardless of risk.
- A **risk-seeking decision maker** also considers risk in making a decision. A risk seeker, unlike a risk-averse decision-maker, will take extra risks in the hope of earning a higher return.

It is often assumed that managers are risk averse, and so will not select a course of action that has higher risk unless it offers a higher expected return sufficient to justify the risk that is taken.

Using probabilities: expected values and simulation

- Expected values
- Simulation

2 Using probabilities: expected values and simulation

2.1 Expected values

One technique for comparing risk and return of different decision options is the use of expected values.

Expected values can be used to analyse information where risk can be assessed in terms of probabilities of different outcomes. Where probabilities are assigned to different outcomes, we can evaluate the worth of a decision as the expected value or weighted average of these outcomes.

Expected value (EV) = weighted average of possible outcomes.

The weighted average value is calculated by applying the probability of each possible outcome to the value of the outcome.

$EV = \sum px$

Where
p = the probability of each outcome and
x = the value of each outcome

An EV is a measurement of **weighted average value**.

A decision might be based on selecting the course of action that offers the highest EV of profit, or the lowest EV of cost. In other words, the 'decision rule' is to select the course of action with the highest EV of profit or the lowest EV of cost.

The main advantage of using EVs to make a decision is that it takes into consideration the probability or likelihood of each different possible outcome, as well as its value (profit or cost)

Example

A business entity has to decide which of three projects to select for investment. The three projects are mutually exclusive, and only one of them can be selected. The projects do not involve any initial capital expenditures.

The expected annual profits from investing in each of the projects will depend on the state of the market. The following estimates of annual profits (operational cash flows) have been prepared:

State of market	Declining	Static	Expanding
Probability	0.4	0.3	0.3
	$000	$000	$000
Project 1	100	200	900
Project 2	0	500	600
Project 3	180	190	200

(**Note**: This type of table is called a 'pay-off table' or a 'pay-off matrix'. It shows all the possible 'pay-offs' or results – NPV, profit and so on – from different possible decisions or strategies).

Required

Identify which project would be selected if the decision is to choose the project with the highest expected value of annual profit.

a

Answer

For each project we can calculate the EV of annual profits.

State of market	Probability	Project 1		Project 2		Project 3	
		Profit	EV of profit	Profit	EV of profit	Profit	EV of profit
		$000	$000	$000	$000	$000	$000
Declining	0.4	100	40	0	0	180	72
Static	0.3	200	60	500	150	190	57
Expanding	0.3	900	270	600	180	200	60
			370		330		189

Based on expected values, project 1 should be selected because it has the highest EV of annual profit.

Advantages of using expected values

Using EVs to make a decision has some advantages.

- An EV is a weighted average value, that is based on all the different possible outcomes and the probability that each will occur.
- It recognises the risk in decisions, based on the probabilities of different possible results or outcomes.
- It expresses risk in a single figure, which makes it easy to compare different options and reach a decision.

Disadvantages of using expected values

Using EVs to make a decision also has some serious disadvantages.

- The probabilities of the different possible outcomes may be difficult to estimate. If the probabilities are unreliable, expected values will also be unreliable.
- The EV is unlikely to be an actual outcome that could occur. In the example above, the EVs for projects 1, 2 and 3 ($370,000, $330,000 and $189,000 respectively) are not expected to occur. They are simply weighted average values.
- Unless the same decision has to be made many times, the average will not be achieved. It is therefore not a valid way of making a decision about the future when the outcome will happen only once.
- An EV is an average value. It gives no indication of the range or spread of possible outcomes. It is therefore an inadequate measurement of risk.
- Expected values might be used by a risk-averse decision-maker, but would not be used by a risk-seeking decision-maker.

Example

Expected values should be reliable for decision-making when:

- Probabilities can be estimated with reasonable accuracy, and
- The outcome from the decision will happen may times, and will not be a 'one-off' event.

The following example illustrates this.

A company manufactures Product K. At the moment, when customers complain that there is one or more defects in the product they have bought, the company repairs the product, at its own cost. Management is now considering a new policy, whereby the company will accept no liability at all for any defects in the product, but will reduce the sales price by $6 per unit.

The estimates of defects in each product, and the costs of repairing each defect, have been estimated from historical records as follows.

Number of defects per product	Probability	Cost of repairing one defect	Probability
		$	
0	0.99	20	0.2
1	0.07	30	0.5
2	0.02	40	0.3
3	0.01		

The company makes and sells 10,000 units of Product K each month.

Would it be cheaper to continue repairing faulty products, or would it be more profitable to reduce the sales price by $6 per unit for all units of the product?

a

Answer

We can calculate the EV of repair costs each month.

Number of defects per product	Probability	EV of defects per product	Cost of repairing one defect	Probability	EV of cost of repair per defect
			$		$
0	0.99	0.00	20	0.2	4.0
1	0.07	0.07	30	0.5	15.0
2	0.02	0.04	40	0.3	12.0
3	0.01	0.03			31.0
		0.14			

The EV of the cost of repairs per unit produced is therefore 0.14 × $31 = $4.34.
The average total cost per month of repairs, given production and sales of 10,000 units, is therefore 10,000 × $4.34 = $43,400.

This is less than the cost of reducing the sales price by $6 ($60,000 per month).

On the basis of cost and profit, the decision should therefore be to continue repairing defects, because this will be less costly by $16,600 per month.

Analysing the expected value

In this example, the estimate of monthly repair costs using an EV is likely to be very reliable, since the probabilities are based on historical records and the outcome happens many times over (10,000 times each month).

The EV is simply a weighted average cost that reflects the following probability distribution of possible outcomes. A slightly simplified probability distribution is as follows.

Defects per product	Probability	Cost of repair	Probability	Joint probability	Total cost of repairs	EV of repair cost
		$			$	$
0	0.99	0	1.00	0.990	0.0	0.00
1	0.07	20	0.20	0.014	20.0	0.28
		30	0.50	0.035	30.0	1.05
		40	0.30	0.021	40.0	0.84
2	0.02	20	0.20	0.004	40.0	0.16
		30	0.50	0.010	60.0	0.60
		40	0.30	0.006	80.0	0.48
3	0.01	20	0.20	0.002	60.0	0.12
		30	0.50	0.005	90.0	0.45
		40	0.30	0.003	120.0	0.36
EV of repair cost per unit						4.34

The EV of cost represents a wide range of possible outcomes, from a 99% probability of $0 repair costs to a 0.3% probability of costs of $120.

3.2 Simulation

Simulation modelling can be used to assess probabilities when:

- there are many different variables in the situation, each with different probable outcomes
- the relationship between these variables might be complex
- extensive information is required about risk (and the range of different possible outcomes), not just the weighted average (EV) or the most likely outcome.

This method of risk assessment might be used, for example, with a complex model such as a financial risk model or an economic model. In business modelling, simulation is probably most closely associated with Monte Carlo simulation modelling

The nature of Monte Carlo simulation modelling

A simulation model will contain a large number of inter-related variables (for example sales volumes of each product, sales prices of each product, availability of constraining resources, resources per unit of product, costs of materials and labour, and so on).

For each variable, there are estimated probabilities of different possible values. These probabilities are used to assign a range of random numbers to each variable. (The random number allocation should reflect the probability distribution).

For example, suppose that in a very simple simulation model, there are four variables: sales volume, sales price, unit variable cost and fixed costs, and that the value of each of these variables is independent of the other three variables. (For example the expected sales volume is independent of the sales price, variable cost and fixed costs.) The possible values for each variable and their associated probability, and the assignment of a range of random numbers, might be as follows.

Sales volume			**Variable cost per unit**		
Units	Probability	Random number range	$	Probability	Random number range
10,000	20%	00 – 19	2	10%	00 – 09
20,000	50%	20 – 69	3	30%	10 – 39
30,000	30%	70 – 99	4	40%	40 – 79
			5	20%	80 – 99
Sales price per unit					
$14	15%	00 – 14	**Fixed costs**		
$15	40%	15 – 54	$200,000	85%	00 – 84
$16	35%	55 – 89	$220,000	10%	85 – 94
$17	10%	90 – 99	$240,000	5%	95 – 99

The model is then used to calculate the value of the outcome or result, for a given set of values for each variable. This simple model can be used to calculate the expected profit, given a combination of sales volume, sales price, variable cost and fixed costs.

The values for each variable are determined by generating random numbers f or each variable. For example if the random numbers 14, 85, 63, 27 are generated for this model, the selected values might be 10,000 units of sale, $16 as the sale price, $4 as the unit variable cost and $200,000 as fixed costs – giving a loss of $80,000.

The model is then used to produce the expected outcome or result again, with a different set of values for each variable, obtained by generating another set of random numbers. The model is used to prepare a large number of different possible outcomes, each time with different combinations of values for all the variables.

As a result, the model will produce a range of many different possible results or outcomes – in this simple example a range of possible annual profit figures. Repeating the simulation many times produces a probability distribution of the possible outcomes and this probability distribution can be analysed statistically.

Simulation modelling therefore leads on to further statistical analysis of the risk in a given situation.

Advantage of the Monte Carlo method

The advantages of Monte Carlo simulation modelling are as follows:

- It gives more information about the possible outcomes and their relative probabilities, so that the risk in a situation or decision (for example the probability distribution of different possible outcomes) can be analysed statistically and in depth.
- It is useful for complex decision problems, where the use of expected values for decision-making would be inappropriate and simplistic.

Limitation of the Monte Carlo method

It is not a technique for making a decision, only for getting more information about the risk and the probability of different possible outcomes.

Sensitivity analysis

- The nature of sensitivity analysis
- Carrying out sensitivity analysis
- Identifying the key variables with senstivity analysis

3 Sensitivity analysis

3.1 The nature of sensitivity analysis

Sensitivity analysis is a method of uncertainty analysis which tests the effect on the expected outcome of changes in the values of key 'variables' or key factors. For example, in budget planning, the effect on budgeted profit might be tested for changes in the budgeted sales volume, or the budgeted rate of inflation, or budgeted materials costs, and so on.

There are several ways of using sensitivity analysis.

- We can estimate by how much an item of cost or revenue would need to differ from their estimated values before the decision would change.
- We can estimate whether a decision would change if estimated sales were x% lower than estimated, or estimated costs were y% higher than estimated. (This is called 'what if…?' analysis: for example: 'What if sales volume is 5% below the expected amount)?

When estimates are uncertain, sensitivity analysis is useful for assessing what would happen if the estimates prove to be wrong. For example, if management consider that their estimates of sales volume might be inaccurate by up to 20%, sensitivity analysis could be used to assess what the profit (or loss) would be if sales volume is 20% less than estimated.

Sensitivity analysis is therefore a common sense approach to assessing the uncertainty in a situation.

3.2 Carrying out sensitivity analysis

The starting point for sensitivity analysis is the original plan or estimate. For example this might be a plan which estimates the expected profit in a budget, or the expected profit from a particular project or transaction.

Key variables are identified (such as sales price, sales volume material cost, labour cost, completion time, and so on). The value of the selected key variable is then altered by a percentage amount (typically a reasonable estimate of possible variations in the value of this variable) and the expected profit is re-calculated.

In this way, the sensitivity of a decision or plan to changes in the value of the key items or key factors can be measured.

An advantage of sensitivity analysis is that if a **spreadsheet model** is used for analysing the original plan or decision, sensitivity analysis can be carried out quickly and easily, by changing one value at a time in the spreadsheet model. For example, cash budgets on a spreadsheet are used extensively with 'what-if analysis' to analyse the possible future cash position in a business.

3.3 Identifying the key variables with sensitivity analysis

Sensitivity analysis can be used to calculate by how much the value of an item (or 'variable') must change before the expected profit or outcome becomes unacceptable. For example, sensitivity analysis can be used to estimate by how much expected sales volume would have to fall short of the estimate before a product became unprofitable.

By applying sensitivity analysis to each variable, it should be possible to identify those that are the most critical, where an error in the estimate could have a large impact on the actual outcome.

Example

A company is considering launching a new product in the market. Profit estimates are as follows:

	$	$
Sales (10,000 units)		200,000
Variable costs:		
Materials	120,000	
Labour	20,000	
		140,000
Contribution		60,000
Fixed costs (all directly attributable)		50,000
Profit		10,000

The estimates of sales volume, sales price, variable costs and fixed costs are uncertain.

Sensitivity analysis can be used to calculate the extent to which the profitability of the product depends on the accuracy of the estimates. We can calculate by how much each of these variables would have to be 'worse' than estimated before the product became loss-making.

Profit can fall by $10,000 before the product ceases to be profitable. Profit would fall by $10,000 if:

- sales volume is $10,000/$60,000 = 16.7% less than expected: this is because each 1% fall in sales volume will reduce contribution by 1%
- the sales price is $10,000/$200,000 = 5% less than expected
- material costs are $10,000/$120,000 = 8.3% more than expected

- labour costs are \$10,000/\$20,000 = 50% more than expected
- fixed costs are \$10,000/\$50,000 = 20% more than expected.

The product would cease to be profitable if a combination of variables turned out worse than expected. In the example above, for instance, the product would cease to be profitable if fixed costs were 10% more than expected and sales volume was also 8.3% less than expected.

Management can use sensitivity analysis to decide whether they have sufficient confidence in the estimates so that they can go ahead with their planned decision (for example, a decision to launch a new product), or whether the uncertainty is so great that it would be too risky to go ahead.

Assessing the uncertainty is a matter of judgement.

Maximax, maximin and minimax regret

- Worst, most likely and best possible outcomes
- Constructing a pay-off table or profit table
- Maximax, maximin and minimax regret decision rules

4 Maximax, maximin and minimax regret

4.1 Worst, most likely and best possible outcomes

When a choice has to be made between two or more mutually exclusive options, the choice might be affected by the different possible outcomes that might occur with each option.

For example, a book publisher might need to decide how many copies of a new book to print. He might be considering three options – to print 1,000 copies, 5,000 copies or 10,000 copies. The most profitable choice of print quantity will depend on the sales demand for the book, which is uncertain. Sales demand might depend on the publicity that the book receives from book reviewers. The decision about the print quantity must be taken before it is known what the publicity and expected sales for the book will be.

The choice between two or more alternative courses of action might be based on the worst, most likely or best expected outcomes from each course of action. A **pay-off table** can be produced which records all possible profit values from the different courses of action.

In the example above, a pay-off table (also called a **profit table**) might be constructed as follows:

Course of action	**Adverse publicity. Bad book reviews**	**Reasonable publicity**	**Good publicity. Excellent reviews**
	Estimated sales 1,000	**Estimated sales 5,000**	**Estimated sales 10,000**
	Profit/loss	*Profit/loss*	*Profit/loss*
Print 1,000 copies	-+ $2,000	+ $2,000	+ $2,000
Print 5,000 copies	- $8,000	+ $10,000	+ $10,000
Print 10,000 copies	- $12,000	+ $1,000	+ $35,000

This pay-off table or profit table can then be analysed, and a choice can be made between the different decision options under consideration.

4.2 Constructing a pay-off table or profit table

A pay-off table can be constructed as follows.

- One side of the table (rows or columns) should list the different mutually exclusive options, from which a choice will be made
- The other side of the table should list the different possible results or outcomes that might occur.
- For each option and possible outcome, the value of the expected outcome (for example, the expected profit) should be entered in the appropriate box.

Example

A shopkeeper must decide how many boxes of apples to buy each day. A box of apples earns contribution of $40 and costs $25. Demand is uncertain and could vary from 30 boxes to 10 boxes. The most likely demand is considered to be 20 boxes.

Any apples that are purchased but not sold will be thrown away at the end of the day.

The shopkeeper has decided that he will buy 10 boxes, 20 boxes or 30 boxes each day, and these are the only three options he wants to consider.

Required: Construct a pay-off table and suggest how many boxes of apples the greengrocer should buy each day.

In the pay-off table below:

- the different decision options are rows in the table
- the different possible outcomes (daily sales demand) are shown in the columns.

For each decision option, we can calculate the daily profit for each possible volume of sales demand.

Course of action	Demand 10 boxes	Demand 20 boxes	Demand 30 boxes
	$	$	$
Buy 10 boxes	150	150	150
Buy 20 boxes	(100)	300	300
Buy 30 boxes	(350)	50	450

Entries in the pay-off table are calculated as follows:

Buy 10 boxes
- Sell 10 boxes Revenue 10 × $40 = $400, costs 10 × $25 = $250, profit = $400 – $250 = $150.
- The shopkeeper cannot meet the demand of 20 or 30 boxes, so if sales demand is more than 10 boxes per day, sales will be just 10 boxes.

  The profit/contribution per day is $150, regardless of actual sales demand.

Buy 20 boxes
- Daily purchase costs = 20 × $25 = $500.
- Sell 10 boxes Revenue 10 × $40 = $400, costs $500, loss = $400 – $500 = $(100).
- Sell 20 boxes Revenue 20 × $40 = $800, costs $500, profit = $800 – $500 = $300.
- If demand is 30 boxes, but the shopkeeper buys just 20 boxes, profit per day will also be $300, and sales demand for 10 boxes will not be met.

Buy 30 boxes
- Daily purchase costs = 30 × $25 = $750.
- Sell 10 boxes Revenue 10 × $40 = $400, costs = $750, loss = $400 – $750 = $(350).
- Sell 20 boxes Revenue 20 × $40 = $800, costs = $750, profit = $800 – $750 = $50.
- Sell 30 boxes Revenue 30 × $40 = $1,200, costs = $750, profit = $1,200 – $750 = $450.

The pay-off table or profit table does not identify the 'best' option. It simply shows what the outcome will be for each decision option, given different possible circumstances that might actually occur.

Management need to use their judgement, given this information, to decide which option to select. The course of action chosen by the company will depend on the attitude to risk of its decision-maker.

2.3 Maximax, maximin and minimax regret decision rules

Choosing between mutually-exclusive courses of action can be stated as 'decision rules'. A decision rule is simply the basis or 'rule' which a decision-maker uses to select between mutually exclusive options.

As suggested earlier in this chapter, the choice between different options might be based on an assessment of probabilities, and the preferred option might be the one that offers the highest expected value of profit. Alternatively, simulation or sensitivity analysis may be used to compare expected profits with the risk or uncertainty, and a choice between the different options based on an assessment of risk and return.

The choice between mutually exclusive options might also be based on any of the following decision rules:

- Maximax rule
- Maximin rule
- Minimax regret rule

To use any of these decision rules, it is helpful to construct a pay-off table.

Maximax decision rule

This is a decision rule based on the view that the decision-maker should select the course of action with the best possible pay-off, such as the highest possible profit.

This approach is based on the view that the decision-maker should seek the highest return, assuming that events turn out in the best way possible. The maximax decision rule can be described as a decision rule for the 'risk seeker'.

Maximin decision rule

This decision rule is based on the view that the decision-maker will select the course of action with the highest expected return under the worst possible conditions. The choice is based on trying to maximise the minimum possible profit.

The decision maker therefore looks at the profit that will occur if the worst possible outcome happens, and will choose the option that offers the highest profit under these conditions.

This decision rule might be associated with a risk-averse decision maker.

Minimax regret decision rule

This decision rule is based on the concept of 'regret'.

'Regret' is the difference between the profit that will be earned by choosing one option choice, and the profit that would have been earned if the most profitable option had been selected, given a particular outcome.

For example suppose that a company has to choose between options 1, 2 and 3, and the profit from each option depends on whether sales demand is weak, average or strong. For each option (1, 2 and 3) and each possible outcome (weak, average or strong sales demand), there is 'regret'. This is the amount by which the profit earned by choosing the option would be worse than 'the best possible profit' from choosing either of the other two options, given the nature of the sales demand.

'Regret' could be defined as the opportunity cost of having made the wrong decision, given the actual conditions that apply in the future.

The decision rule is to select the option with the lowest possible 'regret'.

Example

A business entity has to decide which of three projects to select for investment. The three projects are mutually exclusive, and only one of them can be selected.

The expected annual profits from investing in each of the projects will depend on the state of the market, but the state of the market will not be known until after the choice of project has been made. The following estimates of annual profit have been prepared:

State of market	Declining	Static	Expanding
	$000	$000	$000
Project 1	(100)	120	950
Project 2	50	500	600
Project 3	180	190	200

Which project would be selected if the decision is based on:

(a) the maximax decision rule

(b) the maximin decision rule

(c) the minimax regret decision rule?

a

Answer

Maximax decision rule

The decision should be to select the option that offers the prospect of the highest profit. This is Project 1 where the annual profit would be $950,000 if there is an expanding market.

It does not matter that this project would make a loss of $100,000 if the market turns out to be in decline. The decision rule is to select the option offering the best possible return.

Maximin decision rule

This decision rule is based on the returns that would be obtained if the worst possible outcome occurs. The worst outcome is a declining market. If the market turns out to be in decline, the most profitable option would be Project 3, for which the profit would be $180,000.

Minimax regret decision rule

To apply the minimax regret decision rule, we must first prepare a pay-off table showing the regret the decision-maker would have choosing Project 1, Project 2 or Project 3, and the actual market conditions turn out declining, static or expanding. The regret with each course of action is shown in the pay-off table below.

State of market	Diminishing	Static	Expanding	Maximum regret
	$000	$000	$000	
Project 1	280	380	0	380
Project 2	130	0	350	350
Project 3	0	310	750	750

For example, suppose that the market turns out to be in decline. The most profitable option would be Project 3, for which the profit would be $180,000.

- If Project 1 is selected and the market is in decline the regret will be $280,000, which is the difference between the loss that would be made from Project 1 and the profit that would have been made if the best option (Project 3) had been selected.
- If Project 2 is selected and the market is in decline the regret will be $130,000, which is the difference between the profit that would be made from Project 2 and the profit that would have been made if the best option (Project 3) had been selected.
- If Project 3 is selected, there would be no regret, because the best option would have been chosen, given that the market is in decline.

Similarly, suppose that the market turns out to be static. The most profitable option would be Project 2, for which the profit would be $500,000.

- If Project 1 is selected and the market is static the regret will be $380,000, which is the difference between the profit that would be made from Project 1 and the profit that would have been made if the best option (Project 2) had been selected.
- If Project 3 is selected and the market is static the regret will be $310,000, which is the difference between the profit that would be made from Project 3 and the profit that would have been made if the best option (Project 2) had been selected.
- If Project 2 is selected, there would be no regret, because the best option would have been chosen, given that the market is static.

The regrets can be calculated in the same way on the assumption that the market is expanding.

A table of 'regrets', once completed, shows the amount of the regret for each possible course of action (projects 1, 2 or 3), given each possible outcome (declining, static or expanding market).

The right-hand column of the table shows the maximum regret for each option. This is the maximum amount of regret that will be experienced by selecting that option.

The minimax regret decision option rule is to select the option where the maximum regret is the lowest. In this example, this is Project 2, for which the maximum regret is $350,000.

Conclusion

The maximax, maximin and minimax regret decision rules provide a logical basis for making a choice between mutually exclusive options, where the future conditions are uncertain and there are no probability estimates of what the future conditions might be.

The main disadvantage of choosing between mutually-exclusive courses of action on the basis of the worst, most likely or best possible outcome is that the choice **ignores the likelihood or probability** of the worst, most likely or best outcomes actually happening.

If probability estimates had been available in the previous example for future market conditions (declining, static or expanding market), a different decision rule such as the expected value rule might be more appropriate – because it takes the probabilities of the different outcomes into consideration.

CHAPTER

7

Budgeting

Contents

Objectives of budgeting

- Objectives of budgeting and budgetary control
- Budgeting: co-ordination of corporate and divisional objectives

1 Objectives of budgeting

1.1 Objectives of budgeting and budgetary control

A business entity should plan over the long-term, medium-term and short-term.

- Long-term planning, or strategic planning, focuses on how to achieve the entity's long-term objectives. Strategic objectives might be expressed in general terms, such as the objective of growth in returns to company shareholders. Detailed strategic plans may also be formulated for a planning period of five or ten years (a 'five-year plan' or 'ten-year plan').
- Medium-term or tactical planning focuses on the next year or two. Medium-term plans need to be consistent with longer-term strategic plans, but they are prepared in greater detail.
- Short-term or operational planning covers daily. Weekly or monthly planning at an operational level. These plans need to be consistent with medium-term plans and with the entity's operating standards and policies.

Strategic planning, medium-term planning and operational planning can be seen as a planning hierarchy, each with its own performance targets.

Budgets are medium-term plans for the business, expressed in financial terms. A typical budget is prepared annually and covers the next financial year.

Budgeting can be described as planning at the 'tactical' management level. As annual plans, they must be consistent with the longer-term strategic plans of the organisation. They can also provide a useful benchmark for setting shorter-term operational targets, such as monthly sales volumes and output volumes, efficiency targets, capacity utilisation targets, and so on.

Purposes of budgeting

Budgets have several purposes.

- They provide a link between long-term plans into more detailed short-term operational plans. They are the middle link in the performance hierarchy of the planning system. They help to ensure that detailed planning is linked to the long-term objectives of the entity.
- They should co-ordinate the actions of all the different parts of the entity – so that all parts of the entity work towards the same goals. (This is known as 'goal congruence' and is considered in more detail later.)

- They can be used to communicate the company's plans to the managers and other individuals who have to implement them
- In principle, they can motivate managers and employees, by setting performance targets for achievement. Many entities have incentive schemes, whereby individuals are rewarded, for example with an annual cash bonus, for achieving their performance targets.
- When a budget is approved, it establishes authorised expenditure limits for departments.
- A budget provides a benchmark against which actual performance can be measured, and so acts as an information system for management control (through budgetary control).

Within a budgetary system, there is a close link between budgeting (preparing the financial plan) and budgetary control (monitoring actual performance and possibly taking control measures when actual performance differs from the budget).

1.2 Budgeting: co-ordination of corporate and divisional objectives

Budgets should be an effective method of co-ordinating activities throughout an entity, and reconciling differences between corporate and divisional or departmental objectives.

- Many budgets are prepared on a functional basis, which means that budgets are prepared for each department within the entity (budget for production, for marketing, for the human resources department, for IT services and so on). When companies are organised as divisions, each with its own functional departments, there will be a budget for each division as well as for each functional department within each division.
- In principle, the objectives of each department or division should be consistent with each other. In practice, however, this is not always the case and there may be differences or conflicts between divisional objectives and the objectives of the entity as a whole.

Corporate objectives may be longer-term in nature than divisional objectives. For example, the board of directors of a company may have a five-year plan for profit growth, but heads of divisions might be rewarded with annual cash bonuses based on annual profit performance. In such a situation, the longer-term corporate objectives may conflict with the objectives of divisional managers whose aim might be to maximise profit in the current year in order to maximise their bonuses.

Differences in objectives may also occur when the priorities and concerns of the directors of a company differ from those of the divisional managers. For example, some companies have developed environmental strategies based on creating a sustainable business: a sustainable business is one which operates within its environment without depleting the earth's natural resources or creating irrecoverable damage to the environment through pollution. Although the board of directors of a company may have a sustainable business strategy, divisional managers may not share the same views and may think that the environmental policies of the board are restricting.

Differences in objectives can also exist at departmental level. For example within a manufacturing company:

- The production department managers might have an objective of reducing average costs through longer production runs and greater standardisation of products.
- In contrast, sales managers might have an objective of greater diversity in product design (and shorter production runs) in order to meeting the differing needs of customers in different segments of the market. Greater diversity should result in higher sales revenue.

Conflict can also arise when an entity has a limited budget for new expenditure, and divisional managers might compete for the limited available funds. For example, if there is only a small amount of money available for discretionary spending, it is inevitable that disagreements will occur about how the money should be spent – on research and development, marketing, new IT systems, training of staff, and so on.

The nature of conflicting objectives can vary widely. For the purpose of your examination, you need to be aware that conflicts between corporate and divisional objectives, or between departmental objectives, may exist. In dealing with an examination question on budgeting, you may be required to identify a conflict between objectives in the data or 'case study' in the question.

Resolution of conflicts

One of the benefits of budgeting is that a budget covers all the activities of an entity, and sets performance targets for each department and division. In the process of preparing the budget, any conflicts between objectives will become apparent. The budgeting process provides an opportunity to:

- identify conflicts between corporate and divisional interests
- identify the conflicting objectives of different departments
- establish 'rules' for resolving the differences and making planning choices.

Preparing a budget

- Organising for budgeting
- Stages in the budgeting process
- Preparing a budget: example
- Sources of information for budgeting

2 Preparing a budget

From your previous studies, you should already be familiar with the basic process of preparing an annual budget. It is unlikely that an examination question will test your arithmetical ability to construct a budget, but you should be able to do so if required.

This section provides some revision material about budget preparation.

2.1 Organising for budgeting

Medium-sized and large companies should have a well-defined budget process, because a large number of individuals have to co-ordinate their efforts to prepare the budget plans. The budget process may take several months, from beginning to eventual approval by the board of directors.

The budget process might be supervised and controlled by a special committee (the **budget committee**), consisting of executive directors and senior managers from all the main areas of the business. This committee will co-ordinate the various functional budgets submitted to it for review, and give instructions for changes to be made when the draft budgets are unsatisfactory or the functional budgets are not consistent with each other.

Although the budget committee manages the budget process, the functional budgets (departmental budgets) are usually prepared by the managers with responsibility for the particular aspect of operations covered by that functional budget.

Budget manual

To guide everyone involved in the budgeting process, there should be a budget manual or budget handbook, setting out:

- the key objectives that the budget should plan towards
- the planning procedures and the timetables to follow when preparing the budget
- instructions about the budget details to be submitted to the budget committee in the functional budgets
- responsibilities for the functional budgets (sales budget, production budget, purchases budget, direct labour budget, overhead expenditure budgets, etcetera)
- details of the budget approval process.

To co-ordinate different functional budgets, the budget committee may also specify key assumptions on which the budgets should be prepared, such as assumptions about price inflation or about any restrictions on recruitment of new staff that will be imposed in the next financial year.

2.2 Stages in the budgeting process

The stages in preparing a budget within a manufacturing company might be as follows:

- **Stage 1**: Identify the key budget factor (or principal budget factor). This is the factor that will set a limit on all other activities in the budget. The key budget factor is normally sales volume. However, if there is a shortage of key skilled staff, the availability of skilled labour could be the principal budget factor.
- All the functional budgets should be prepared within the limitation of the key budget factor. For example, even if the company has the capacity to produce more output, it should not produce more than it can profitably sell. In such a situation, the production budget will be limited by the sales budget.
- **Stage 2**: Prepare the functional budget for the key budget factor. Usually, this means that the first functional budget to prepare is the sales budget.
- **Stage 3**: Prepare the other functional budgets, in logical sequence where necessary. When the sales budget has been prepared, a manufacturing organisation can then prepare budgets for inventories, a production budget, direct labour budgets and materials purchasing budgets. Expenditure budgets should also be prepared for overhead costs (production overheads, administration overheads and sales and distribution overheads).
- **Stage 4**: Submit the functional budgets to the budget committee for review and approval. The functional budgets are co-ordinated by the budget committee, which must make sure that they are both realistic and consistent with each other. It is not unusual for functional budgets to be rejected by the budget committee and sent back for revising. Several versions of a functional budget might be needed before a version acceptable to the budget committee is eventually produced.
- **Stage 5**: Prepare the 'master budget'. This is the budget statement that summarises the plans for the budget period. The master budget might be presented in the form of:
  - a budgeted income statement for the next financial year
  - a budgeted statement of financial position as at the end of the next financial year
  - a cash budget or cash flow forecast for the next financial year.
- It should be possible to prepare the master budget statements from the functional budgets.
- **Stage 6**: The master budget and the supporting functional budgets should be submitted to board of directors for approval. The board approves and authorises the budget.
- **Stage 7**: The detailed budgets are communicated to the managers responsible for their implementation.

- **Stage 8**: Control process. The annual budget should be divided into a number of shorter control periods, such as 12 one-month control periods. Actual results for each control period should be recorded and reported to management. Actual results should be compared with the budget, and significant differences should be investigated. The reasons for the differences or variances should be discovered, and where appropriate, control measures should be taken. Comparing actual results with the budget therefore provides a system of control. The managers responsible for activities where actual results differ significantly from the budget should be held responsible and accountable.

2.3 Preparing a budget: example

A 'master budget' is the budget for an entire organisation, and consists of functional budgets, together with:

- a budgeted income statement for the financial year
- a cash budget
- a budgeted statement of financial position as at the year end
- possibly, a capital expenditure budget (covering more than one financial year, but updated on a 'rolling' basis each year).

The following example illustrates the logical approach that can normally be used to prepare functional budgets and a master budget for a manufacturing organisation. (The mathematics of budgeting for service industry organisations are usually easier).

It is assumed here that the key budget factor is sales demand, and the initial functional budget to prepare is the sales budget.

In practice, budgets are usually much more complex, and are commonly prepared with computer models, such as a **spreadsheet model**.

Example

Yellow Co makes and sells two products, Product P and Product Q. The direct production costs of these products are as follows:

	Product P	$	Product Q	$
Direct materials				
Material A	(2 kg × $0.80)	1.60	(0.5 kg × $0.80)	0.40
Material B	(0.5 kg × $2)	1.00	(3 kg × $2)	6.00
Material C	(1 kg × $4)	4.00		-
		6.60		6.40
Direct labour				
Grade X	(0.25 hrs × $10)	2.50	(0.5 hrs × $10)	5.00
Grade Y	(0.25 hrs × $8)	2.00	(0.75 hrs × $8)	6.00
		4.50		11.00
Total direct cost		11.10		17.40

The sales price and expected sales volume for each product next year are as follows:

	Product P	Product Q
Sales price per unit	$20	$30
Budgeted sales volume	20,000 units	30,000 units

Budgeted overhead costs are as follows:

Production overheads	$80,000	including depreciation charges of $20,000
Administration overheads	$120,000	including depreciation charges of $10,000
Selling and distribution overheads	$190,000	including depreciation charges of $10,000

Bad debts are expected to be 2% of sales, and should be provided for. The costs of bad debts and allowances for doubtful debts are not included in the overhead costs above.

Inventories of raw materials at the beginning of January, and planned closing inventories at the end of January, are as follows:

Direct material	Inventory	
	At beginning of January	At end of January
	kilos	kilos
Material A	5,000	6,000
Material B	5,500	4,000
Material C	1,000	2,500

No further changes in inventory levels are planned during the year.

The sales budget

The sales budget is prepared for each product individually, and for sales revenue in total.

Product	Sales quantity	Sales price	Sales revenue
	units	$	$
P	20,000	20	400,000
Q	30,000	30	900,000
Total			1,300,000

The production budget

The production budget is calculated initially in units, although a production cost budget can be prepared later. The production budget in units is prepared for each product, as follows:

	Units
Sales budget in units	S
Plus budgeted closing inventory	C
Minus opening inventory	(O)
Production budget	(S+C-O)

The production budget for each product in units is the sales budget in units plus any planned increase in finished goods inventories (and work-in-progress inventories) minus the opening inventories of finished goods (and work in progress).

In this example, there are no planned changes in finished goods inventories; therefore the production budget in units is the same as the sales budget.

The direct materials usage budget

The direct materials usage budget is a statement of the quantities of direct materials required for production, and their cost. The budget is prepared for each item of material separately, but a total usage cost can also be shown.

	Material A	Material B	Material C	Total
	kilos	kilos	kilos	
To make 20,000 P	40,000	10,000	20,000	
To make 30,000 Q	15,000	90,000	0	
Total quantities	55,000	100,000	20,000	
Price per kilo	$0.80	$2	$4	
Total cost	$44,000	$200,000	$80,000	$324,000

The direct labour budget

The direct labour budget is similar to the direct materials usage budget. It is a statement of the quantities of direct labour required for production, and its cost. The budget is prepared for each grade of labour separately, but a total direct labour cost can also be shown.

	Grade X	Grade Y	Total
	hours	hours	
To make 20,000 P	5,000	5,000	
To make 30,000 Q	15,000	22,500	
Total hours	20,000	27,500	
Cost per hour	$10	$8	
Total cost	$200,000	$220,000	$420,000

The material purchases budget

The purchases budget is the budget for materials purchases. The purchases budget might be prepared for all materials, direct and indirect, or for direct materials only. The purchases budget differs from the materials usage budget by the amount of the planned increase or decrease in inventory levels of materials in the budget period.

The purchase quantities are calculated first, and these are converted into a purchases cost at the budgeted price for each material item. Purchase quantities are calculated as follows:

	Units
Material usage budget in units	S
Plus budgeted closing inventory	C
Minus opening inventory	(O)
Purchases budget, in units	(S+C-O)

The purchases budget in our example is as follows:

	Material A	Material B	Material C	Total
	kilos	kilos	kilos	
Usage budget	55,000	100,000	20,000	
Closing inventory	6,000	4,000	2,500	
	61,000	104,000	22,500	
Opening inventory	(5,000)	(5,500)	(1,000)	
Budgeted purchases	56,000	98,500	21,500	
Price per kilo	$0.80	$2	$4	
Purchases budget in $	$44,800	$197,000	$86,000	$327,800

Budgeted income statement

The functional budgets, together with budgets for the overhead costs and any other items of cost, should be sufficient to prepare a budgeted income statement for the period.

In our example, we need to remember that there should be bad and doubtful debt provisions for the year of 2% × $1,300,000 = $26,000

The budgeted income statement below is presented in a marginal costing format.

	Product P	Product Q	Total
	$	$	$
Sales	400,000	900,000	1,300,000
Variable cost of sales			
Direct materials	132,000	192,000	324,000
Direct labour	90,000	330,000	420,000
Total variable costs	222,000	522,000	744,000
Contribution	178,000	378,000	556,000
		$	
Production overheads		80,000	
Administration overheads		120,000	
Sales and distribution overheads		190,000	
Bad and doubtful debts		26,000	
			416,000
Budgeted profit			140,000

2.4 Sources of information for budgeting

Budgets are prepared from a large number of forecasts and estimates. Some of the information comes from sources within the entity and other information is obtained from external sources.

An important source of internal information is the entity's cost and management accounts. Results in the current financial year are often used as a basis for budgeting costs and revenues in the next year.

Some information is also needed from external sources. For example:

- Market research information, or information about competitors, will be useful for preparing sales budgets for the next financial year. This information might be gathered by the entity's marketing department or sales team.
- Economic information, such as government forecasts, might be useful for estimating the probable rate of inflation in certain costs (such as wages and salary increases), and the likely level of interest rates and foreign exchange rates.

Budgetary systems

- Top-down and bottom-up budgeting
- Periodic budgets and rolling budgets (continuous budgets)
- Incremental budgeting and zero based budgeting (ZBB)
- Activity based budgeting
- Budgeting: feed-forward control
- Difficulties in changing a budgetary system
- Budgetary systems and uncertainty in the environment

3 Budgetary systems

A budgetary system is a system for preparing budgets (and producing control reports for the purpose of budgetary control). There are several budgetary systems, and entities will choose a system that is appropriate for their needs and circumstances.

3.1 Top-down budgeting and bottom-up budgeting

Top-down budgeting

In a system of **top-down budgeting**, the budget targets for the year are set at senior management level, perhaps by the board of directors or by the budget committee. Top-level decisions might be made, for example, about the amount of budgeted profit that will be achieved, the growth in sales, reductions in production costs and other functional department costs, and so on.

Divisions and departments are then required to prepare a budget for their own operations that is consistent with the budget imposed on them from above.

For example, the board of directors might state that in the budget for the next financial year, sales revenue will grow by 5% and profits by 8%. The sales director would then be required to prepare a more detailed sales budget in which the end result is a 5% growth in annual sales revenue. A production budget and other functional budgets will then be prepared that is consistent with the sales budget. The target for 8% growth in profits cannot be checked until all the functional budgets have been prepared in draft form. If the initial draft budgets fail to achieve 8% growth in profits, some re-drafting of the budgets will be required.

This process is called top-down budgeting because it starts at the top with senior management and works its way down to the most detailed level of budgeting within the management hierarchy. This might be departmental level or possibly an even smaller unit level, such as budgets for each work section within each department. A system of top-down budgeting would normally be associated with an entity where management control is highly centralised.

Bottom-up budgeting

In a system of **bottom-up budgeting**, budgeting starts at the lowest level in the management hierarchy where budgets are prepared. This may be at work section level or departmental level. The draft lower-level budgets are then submitted to the next level of management in the hierarchy, which combines them into a co-ordinated budget, for example a departmental budget. Departmental budgets might then be submitted up to the next level of management, which might be at divisional level, where they will be combined and co-ordinated into a divisional budget. Eventually budgets for each division will be submitted up to the budget committee or board of directors.

The budget committee or board of directors will consider the draft budgets they receive, and ask for changes to be made if the overall master budget is unsatisfactory. Re-drafting of budgets will then go on until the master budget is eventually approved.

In a system of bottom-up budgeting, lower levels of management are likely to have more input to budget decision-making than in a top-down budgeting system, and it is associated with budgeting in entities where management authority is largely decentralised.

3.2 Periodic budgets and rolling budgets (continuous budgets)

Periodic budgets

A **periodic budget** is a budget for a particular time period, typically the financial year. The budget is not changed or revised during the year, and it is a fixed budget for the period. A company might therefore prepare a periodic budget for its financial year 2010, which will then be replaced the next year by the periodic budget for 2011, which will then be replaced the year afterwards by the periodic budget for 2012, and so on.

Traditional budgeting systems are periodic budgeting systems. When periodic budgets are used, an underlying assumption is that revenues and expenditure within the financial year should be fairly predictable and that it is unlikely that any unexpected events will occur during the year that will make the budget unrealistic or irrelevant.

Periodic budgets are much less useful, however, when future events are unpredictable and big changes might happen unexpectedly during the course of the financial year. When events change rapidly, the original budget loses its relevance because of the extent of the changes that have occurred. For example an entity might operate in a country where the annual rate of inflation might be anywhere between 200% and 400% during the year. Given the difficulty in forecasting what the actual rate of inflation will be, but the probability that it will be very high, it would make sense to review the budget regularly, and adjust it to allow for revised estimates of what the rate of inflation will be.

When unexpected changes are likely to occur, or when future events are difficult to predict with accuracy, it might be advisable for an entity to prepare revised budgets much more frequently, as a matter of routine.

Rolling budgets

A **rolling budget**, also called a **continuous budget**, is a budget that is continuously being updated. Each updated budget is for a given length of time, typically 12 months. For example a new rolling budget may be prepared every three months so that as one quarter of a 12-month budget ends, a new 12-month budget is prepared with an additional quarter added at the end. In this way a new 12-month budget is prepared every three months.

A rolling budget can therefore be defined as 'a budget continuously updated by adding a further period, say a month or a quarter, and deducting the earliest period'.

Rolling budgets are most useful where future costs or activities cannot be forecast reliably, so that it makes much more sense for planning purposes to review the budget regularly, but to plan ahead for a full planning period each time.

Rolling budgets might be particularly useful for cash budgeting. An organisation must ensure that it will always have sufficient cash to meet its requirements, but actual cash flows often differ considerably from the budget. It might therefore be appropriate to prepare a new annual cash budget every month, and so have 12 rolling cash budgets every year.

The main disadvantage of rolling budgets is the time and cost required to prepare new budgets at frequent intervals throughout each financial year. Budgeting takes up a large amount of management time and effort, so that rolling budgets could make it difficult to find sufficient time for their other responsibilities.

3.3 Incremental budgeting and zero based budgeting (ZBB)

Incremental budgeting and zero based budgeting are two different approaches to estimating budgeted expenditure. The difference between them is most obvious in budgeting for administrative activities (and other overhead activities) and overhead costs.

Incremental budgeting

With **incremental budgeting**, the budgeted expenditure for the next financial period is estimated by taking expenditure in the current period as a starting point. An incremental amount is then added for:

- inflation in costs next year, and
- possibly, the cost of additional activities that will be carried out next year.

In its simplest form, incremental budgets for a financial period are prepared by taking the expenditure in the current year, and adding a percentage to allow for inflation next year.

This approach to budgeting is very common in practice because of its relative simplicity. For example in order to prepare a labour cost budget, it might be sufficient for the manager to make assumptions about (1) changes in staffing levels and (2) the general level of pay rises, and apply these assumptions to the actual labour costs for the current year that is just ending. If labour costs in the current year are \$2.4 million, and if it is assumed that the work force will increase by 2% next year and that wages and salaries will increase by an average of 4%, a labour cost budget can be prepared simply as: \$2.4 million × 102% × 104% = \$2.546 million.

A serious weakness of incremental budgeting, however, is that there is no incentive to eliminate wasteful or unnecessary spending from the budget. For example suppose that next year's budget is based on this year's actual spending plus an allowance for inflation. If there has been wasteful spending in the current year, next year's budget will include an allowance for the wasteful spending, plus inflation.

Incremental budgeting can also encourage more waste (sometime scalled 'budget slack'), because managers will try to spend up to their budget limit, so that in the next financial year their budgeted spending allowance will not be reduced.

Zero based budgeting (ZBB)

Zero based budgeting (ZBB) has a completely different approach to budgeting. It aims to eliminate all wasteful spending ('**budget slack**') and only to budget for activities that are worth carrying out and that the organisation can afford. Planning starts from 'zero' and all spending must be justified.

It can be particularly useful in budgeting for activities that are prone to wasteful spending and budget slack, such as activities in a bureaucracy. ZBB might be usefully applied, for example, to the budgets of government departments.

The approach used in ZBB is as follows:

- The minimum level of operations in a department or budget centre is identified. These are the essential things that the department will have to do. A budget is prepared for this minimum essential level.
- All other activities are optional additional activities that need to be justified, in terms of the benefits obtained in return for the costs. Each additional activity is called a **decision package**.

A decision package is a program of activities that will achieve a specific purpose during the budget period. Each decision package must have a clearly-stated purpose that contributes to the goals and objectives of the entity.

There are two types of decision package.

- **Decision packages for a minimum level of operation**. For example, there may be a minimum acceptable level of training for a group of employees. There may be several alternative decision packages for providing the training – internal courses, external courses, or computer-based training programmes. An expenditure estimate should be prepared for each alternative basic decision package.

- **Incremental decision packages**. These are programmes for conducting a more extensive operation than the minimum acceptable level. For example, there may be incremental decision packages for providing some employees with more training than the essential minimum, or for having more extensive supervision, or more extensive quality control checks. For incremental decision packages, an estimate should be made of the cost of the incremental operation, and the expected benefits. Incremental decision packages are optional activities: the entity need not include them in the budget.

For each decision package, a budget decision must be made about whether to include it in the budget and the following should be considered:

- Purpose of the activity (decision package)
- The likely results and benefits from the activity
- The resources required for the activity, and their cost
- Alternative ways of achieving the same purpose, but perhaps at a lower cost
- A comparison of the costs and benefits of the activity.

A zero based budget is then prepared as follows:

- A decision must be taken to provide for a minimum level of operation. This means deciding for each basic operation:
  - Whether or not to perform the operation at all – do the benefits justify the costs?
  - If the operation is performed at a basic level, which of the alternative basic decision packages should be selected?
- Having decided on as basic level of operations, a basic expenditure budget can be prepared.
- The next step is to consider each incremental decision package, and decide whether this additional operation, or additional level of operations, is justified. An incremental decision package is justified if the expected benefits exceed the estimated costs.
- A budget can then be prepared consisting of all the selected basic decision packages and incremental decision packages.
- If the total expenditure budget is too high, when all these decision packages are included, some incremental decision packages should be eliminated from the budget. One method of doing this is to rank the incremental decision packages in an order of priority (typically in order of net expected benefits, which are the expected benefits minus the estimated incremental costs). The decision packages at the bottom of the priority list can then be eliminated from the budget, until total budgeted expenditure comes within the maximum permitted spending limit.

Extensive use of value judgements by managers will be needed to rank decision packages in a priority order. This is because the expected benefits from incremental activities or incremental programmes are often based on guesswork and opinion, or on forecasts that might be difficult to justify.

The advantages of zero based budgeting

There are some obvious benefits from zero based budgeting

- All activities are reviewed and evaluated., and no activity is included in the budget unless it appears to be worthwhile.
- Inefficiency in using resources and inefficiency in spending should be identified and eliminated.
- A ZBB approach helps managers to question the reason for doing things rather than simply accepting the current position.
- When total expenditure has to be reduced, ZBB provides a priority list for activities an expenditures.
- ZBB encourages greater involvement by managers and might motivate them to eliminate wasteful spending.

The disadvantages of zero based budgeting

However, there are also some severe disadvantages to ZBB

- ZBB is a very time-consuming process, particularly if undertaken every year.
- It is also costly, because it takes more time.
- Planners need to understand the principles of relevant costing and decision-making, in order to compare properly the incremental costs and incremental benefits of activities (decision packages).
- Managers might see ZBB as a threat, and an attempt by senior management to cut back their expenditure allowances in the next budget year.
- When incremental decision packages are ranked in priority order, there may be disputes between managers of different decision units (budget cost centres), as each tries to protect his own spending levels and argue that budget cuts should fall on other cost centres.

In view of the large amount of management time that is required to prepare a zero based budget, an entity may decide to produce a zero based budget periodically, say every three years, and to prepare incremental budgets in the intervening years.

In order to maintain the support of budget cost centre managers for a system of ZBB, it is also necessary to make sure that any system of performance-based rewards (such as annual bonuses for keeping spending within budget limits) is not affected by the use of ZBB. If managers feel that their rewards will be threatened – for example because it will be difficult to keep spending within the ZBB limits – they are unlikely to give their support to the ZBB system.

ZBB and performance monitoring

A successful system of ZBB requires methods for monitoring actual performance and comparing actual performance with the budget.

- Each decision package must therefore have one or more measurable performance objectives. The package must specify the objective or objectives, and the activities or operations that will be required to achieve those objectives.

- Actual performance should be measured and compared with the objectives. Management must be informed whether or not the performance objectives are achieved.

3.4 Activity based budgeting

Activity based budgeting applies the principles of activity-based costing to the preparation of budgets

- Activities drive costs. By identifying cost drivers, it might be assumed that costs that are directly attributable to an activity can be more accurately forecast and monitored.
- In service cost centres and non-production departments many costs are likely to be caused by activities outside of the control of the department. By identifying cost drivers, activity levels are more visible. For example, maintenance requirements may be a function of the age of the machinery and level of usage. The maintenance manager will require estimates from the production manager to enable a budget to be produced.
- With activity-based budgeting it might also be possible to identify activities that do not add value, and their associated costs. These activities can then be eliminated from the budget.

Example

A manufacturing company has identified that a large part of its overhead costs are incurred in handling customer orders, and that the same effort goes into handling a small order as the effort required to deal with a large order. Order sizes differ substantially. The company makes four products.

A system of activity-based budgeting is used, and each activity is treated as a cost centre for the purpose of budgeting. For the order-handling activity, budgeted directly-attributable expenditure is $2,500,000 for the year.

Budgets for sales volumes and sales orders are as follows.

Product	Number of orders	Total number of units ordered
W	150	60,000
X	220	33,000
Y	40	40,000
Z	90	27,000
	500	160,000

It is assumed that the cost driver for order handling is the number of orders handled.

The budgeted order handling cost will be $2,500,000/50 = $50,000 per order. Overhead costs will be charged to products in the budget as follows:

Product	Number of orders	Budgeted cost
		$
W	150	750,000
X	220	1,100,000
Y	40	200,000
Z	90	450,000
	500	2,500,000

Example

The costs of a marketing department are found to be driven by the number of products, but the time and resources required for new products is much more than for existing products.

For the purpose of budgeting, marketing activities have therefore been divided into three categories: new product activity, existing product activity and general departmental administration costs.

For new and existing product activities, the cost driver is assumed to be the number of products.

Budgeted marketing costs are allocated to each of the three budget areas, and a budget is prepared as follows.

	Total	New product activities	Existing product activities	Departmental administratio n
	$000	$000	$000	$000
Salaries	150	75	67	8
Materials	85	52	31	2
Other costs	62	40	20	2
Total cost	297	167	118	12
Number of products (= cost driver)		8	16	
Cost per cost driver		$20,875	$7,375	

If the actual number of new or existing products is different from the budget level, the budget can be flexed to provide a more realistic measure of expected costs.

3.5 Budgeting: feed-forward control

Budgetary systems are systems of control as well as planning systems. In a normal budgetary control system, actual results in each control period (month) are compared with the budgeted results for the period. (Sometimes, cumulative actual results for the year to date are also compared with budgeted results for the year to date.)

Information that provides a comparison between budgeted results (planned results) and actual results is called **feedback**.

Instead of basing budgetary control on feedback, there might be a system of feed-forward control. With feed-forward control, control information is based on a comparison with a revised up-to-date forecast of what is now expected to happen in the budget year.

Feed-forward control involves a comparison between:

- a revised up-to-date forecast, and
- the original budget.

Within a budgetary control system, it should be possible in each control period o compare:

- budgeted and actual results for the most recent control period (feedback control)
- cumulative budgeted and actual results for the financial year to date (feedback control)
- forecast results and the original budgeted results for the financial year (feed-forward control).

A problem with feed-forward control, however, is that up-to-date forecasts of what will happen in the rest of the financial year might not be reliable. The quality of the control system depends on the quality (reliability) of the forecast information.

3.6 Difficulties in changing a budgetary system

Each of the budgetary systems described in this section offers some benefits, and one system is not necessarily better than another. The senior management of an entity may decide that the budgetary system should be changed, and a new system of budgeting (such as rolling budgets, zero-based budgets, or activity-based budgets) should be introduced.

However, the practical difficulties of switching from one budgetary system to another should be understood, and the benefits of using a new system might not be sufficient to justify the problems in changing over. Difficulties that could arise with the introduction of a new budgetary system include:

- Resistance of the managers responsible for budgeting: managers might be reluctant to change to a new system from a system they understand and are familiar with.

- Suspicion about the motives of senior management for wanting to make the change.
- The time required to prepare the new system of budgeting, including the time required to train managers in how to operate the new system.
- Practical difficulties with implementing the new system, such as difficulties in calculating the relevant costs for a decision package (ZBB) or difficulties in preparing reliable up-to-date forecasts (feed-forward control).

3.7 Budgetary systems and uncertainty in the environment

One of the biggest problems with budgeting is uncertainty about what will happen in the future. To prepare a budget, it is necessary to plan for what will happen one year or more in advance and this means having to make assumptions about what will happen in the future.

When an entity operates in a fairly stable environment, it might be possible to predict the future with reasonable confidence. However, when the business environment is unstable and unpredictable it is extremely difficult to make reliable plans for the future.

This does not mean that budgeting is a pointless exercise when the environment is uncertain. It does mean however that an entity should prepare budgets with an understanding that events might turn out differently from what is expected.

There are several ways of doing this.

- It might be possible to make several different predictions for the future and prepare a budget for each possible outcome. When the financial year begins, as soon as it becomes apparent which prediction is closest to what is actually happening, the entity can switch to the budget for that outcome.
- An entity may prepare flexible budgets, which can be used if the actual volume of sales and activity turns out to be higher or lower than originally planned.
- Budgets could be revised more frequently, and a system of rolling budgets introduced.
- For control purposes, instead of comparing actual results with budget, it might be appropriate to use feed-forward control and in each control period prepare an updated forecast of what will happen in the rest of the financial year.
- If the entity is concerned that the events could turn out unfavourably due to adverse changes in the business environment, it might carry out 'stress testing' to assess how the entity would survive if these adverse events were to occur – and to make contingency plans.

When uncertainty about the future relates to uncertainty about sales demand and sales volumes, budgetary control systems provide for this. Variance reports can be prepared using flexed (or flexible) budgets.

Fixed and flexed budgets

- The nature of fixed budgets and flexible budgets
- Flexed budgets using marginal costing
- Flexed budgets using absorption costing

4 Fixed and flexed budgets

4.1 The nature of fixed budgets and flexible budgets

In a budgetary system, there is a **fixed budget**. This is the budget for the financial year that is formally approved by the board of directors or budget committee, and which establishes the goals and performance targets for the year.

A **flexible budget** is defined as a 'budget which, by recognising different cost behaviour patterns, is designed to change as the volume of output or activity changes' (CIMA).

Flexible budgets might be prepared on the assumption that all costs are fixed costs, variable costs or mixed costs (part fixed and part variable), and that fixed costs and the variable cost per unit are constant at all levels of output and sales. Alternatively, flexible budgets can allow for expected step increases in fixed costs as the volume of activity rises, and for changes in the unit variable costs at different activity levels.

Flexed budgets and budgetary control

The most common use of flexible budgets is for budgetary control, where actual results in each control period are compared with the budget.

For each control period, the budget is 'flexed'. When the budget is flexed this means that a flexible budget is prepared for the actual level of sales and production in the period. Actual revenues and costs are then compared with the flexed budget, and the differences are reported as variances.

Fixed and flexed budgets therefore provide the framework for a system of budgetary control through variance analysis.

It is normally assumed when flexing budgets for budgetary control purposes that fixed costs and the variable costs per unit are the same at all activity levels.

4.2 Flexed budgets using marginal costing

The simplest approach to preparing flexed budgets is to:

- prepare the fixed and the flexed budget using marginal costing, and
- assume that there is no change in inventory levels of finished goods or work in progress during the period.

The following example shows the fixed budget for a month, the actual results for the month and a flexed budget, based on marginal costing, where production and sales volumes in the period are the same.

Example

	Original budget	Flexed budget	Actual results	Variance
		(A)	**(B)**	**(A) – (B)**
Sales units	10,000	15,000	15,000	
	$	$	$	$
Sales revenue	250,000	375,000	361,000	
Sales price variance				14,000 (A)
Variable costs				
Direct materials	60,000	90,000	94,000	
Direct materials cost variance				4,000 (A)
Direct labour	70,000	105,000	97,000	
Direct materials cost variance				8,000 (F)
Variable production overheads	20,000	30,000	23,000	
Variable production overheads cost variance				7,000 (F)
Variable sales overheads	10,000	15,000	18,000	
Variable sales overheads cost variance				3,000 (A)
Total variable costs of sales	160,000	240,000	232,000	
Contribution	90,000	135,000	129,000	6,000 (A)
Fixed production costs	40,000	40,000	55,000	
Fixed production overhead expenditure varance				15,000 (A)
Other fixed costs	30,000	30,000	35,000	
Other fixed costs expenditure variance				5,000 (A)
Profit	20,000	65,000	39,000	26,000 (A)

The variances in the right hand column are calculated by comparing the actual results with the flexed budget. A variance is adverse when actual results are worse than the flexed budget, and favourable when actual results are better than the flexed budget.

A sales volume variance is also calculated. In a system of marginal costing, this is the difference between the total contribution in the fixed budget and the total contribution in the flexed budget. Here the sales volume variance is $45,000 favourable (90,000 – 135,000). It is favourable because actual sales were higher than in the fixed budget; therefore actual contribution should be higher.

Actual results can be compared with the expected results in the fixed budget, for the purpose of control reporting, as follows:

Operating statement summary, marginal costing

	$		$	
Budgeted profit			20,000	
Sales volume variance			45,000	(F)
Sales price variance			14,000	(A)
			51,000	
Cost variances				
Direct materials	4,000	(A)		
Direct labour	8,000	(F)		
Variable production overheads	7,000	(F)		
Variable sales overheads	3,000	(A)		
Fixed production overhead expenditure	15,000	(A)		
Other fixed costs expenditure	5,000	(A)		
			12,000	(A)
Actual profit			39,000	

Changes in inventory levels

When there is a change in inventory levels in the period, so that sales and production volumes are different, the comparison of actual results with the flexed budget should be adjusted slightly.

The flexed budget for production costs should be the production costs for all items produced in the period. (The flexed budget for sales costs should be for the actual volume of sales).

An additional line should be introduced into the table, for 'increase in inventory' or 'reduction in inventory'. A reduction in inventory should be added to the costs for the period, and an increase in inventory should be reduced from the total costs. The purpose of this adjustment is to adjust the figures for production costs in the table from:

- production costs of items produced to
- production cost of goods sold.

(Note: The same adjustment is required when absorption costing is used, except that the increase or decrease in inventory will be valued at full production costs.)

4.3 Flexed budgets using absorption costing

A similar approach to preparing flexed budgets can be used when a system of absorption costing is operated. An important difference is that in the flexed budget, the production overhead costs should be for the amount of production overheads absorbed in the period, not the actual production overhead expenditure.

Example

This example is similar to the previous example, except that there is a system of overhead absorption and the fixed production overhead absorption rate is $4 per unit (based on the fixed budget). Sales and production quantities are the same, so there is no change in inventory levels.

	Original budget	Flexed budget	Actual results	Variance
		(A)	(B)	(A) – (B)
Sales units	10,000	15,000	15,000	
	$	$	$	$
Sales revenue	250,000	375,000	361,000	
Sales price variance				14,000 (A)
Variable costs				
Direct materials	60,000	90,000	94,000	
Direct materials cost variance				4,000 (A)
Direct labour	70,000	105,000	97,000	
Direct materials cost variance				8,000 (F)
Variable production overheads	20,000	30,000	23,000	
Variable production overheads cost variance				7,000 (F)
Fixed production costs (absorbed in flexed budget, actual spending in 'actual results' column)	40,000	60,000	55,000	5,000 (F)
Total production cost of sales	190,000	285,000	269,000	
Gross profit before other costs	60,000	90,000	92,000	2,000 (F)
Variable sales overheads	10,000	15,000	18,000	
Variable sales overheads cost variance				3,000 (A)
Other fixed costs	30,000	30,000	35,000	
Other fixed costs expenditure variance				5,000 (A)
Profit	20,000	45,000	39,000	6,000 (A)

The fixed overhead total cost variance is the over-absorbed or under-absorbed overhead. Here there is over-absorbed overhead of $5,000, and the total fixed overhead cost variance is therefore $5,000(F).

(Absorbed fixed overheads = $60,000 at $4 per unit; actual fixed overheads = $55,000; therefore over-absorbed = $5,000).

This total fixed production overhead variance can be analysed into an expenditure variance and a volume variance. The variances are calculated in the same way as for standard costing.

- There is an expenditure variance, which is the difference between the budgeted fixed production overhead expenditure ($40,000) and the actual fixed production overhead expenditure ($55,000), giving an expenditure variance of $15,000(A).

  The volume variance is the difference between the budgeted production volume (10,000 units) and the actual production volume (15,000 units). This is 5,000 units (favourable), and at an absorption rate of $4 per unit, the fixed production overhead volume variance is $20,000 (F) [= 5,000(F) × $4].
- In this example, other fixed costs are not included in the absorption costing system, and a treated as a fixed period cost. The budgeted profit per unit is therefore the sales price minus the full production cost minus the variable sales cost per unit:
- Budgeted profit per unit = $25 - $19 - $1 = $5.
- The sales volume variance is measured at this budgeted profit of $5 per unit. Since actual sales exceeded sales in the fixed budget by 5,000 units the total sales volume variance in this example is $25,000 (F). It is favourable, because actual sales volume exceeded the budget by 5,000 units. This sales volume variance in the table above is shown as the difference between the fixed budget profit and the flexed budget profit.

Operating statement summary, absorption costing

	$		$	
Budgeted profit			20,000	
Sales volume variance			25,000	(F)
Sales price variance			14,000	(A)
			31,000	
Cost variances				
Direct materials	4,000	(A)		
Direct labour	8,000	(F)		
Variable production overheads	7,000	(F)		
Variable sales overheads	3,000	(A)		
Fixed production overhead total variance	5,000	(F)		
Other fixed costs expenditure	5,000	(A)		
			8,000	(F)
Actual profit			39,000	

The fixed production overhead total cost variance could be shown instead as the separate expenditure variance ($15,000 (A)) and volume variance ($20,000 F)).

Behavioural aspects of budgeting

- Behavioural problems in budgeting
- Budgeting as a bargaining process
- Budgets, incentives and performance level
- Motivation: paarticipative budgets and imposed budgets
- Behavioural aspects of budgeting: concluding remarks

5 Behavioural aspects of budgeting

5.1 Behavioural problems in budgeting

In principle, the budgeting process should be a co-operative effort between managers throughout the entity, and the budget that is eventually produced and approved should be one that aims to optimise performance and profits.

Unfortunately in practice, human behaviour in the budgeting process often has a negative effect. Instead of co-ordinating their efforts, managers are often in conflict with each other. Instead of preparing a budget that is best for the entity as a whole, managers are often much more interested in preparing a budget in their own interests for their area of responsibility.

There are several possible reasons why behavioural factors in budgeting can be damaging for the entity.

- Misunderstanding and worries about cost-cutting.
- Opposition to unfair targets set by senior management
- Sub-optimisation
- Lack of goal congruence
- Budget slack or budget bias

Misunderstanding and worries about cost-cutting

Budgeting is often seen by managers as an opportunity to cut back on expenditure and find ways to reduce costs, for example by getting rid of some staff. Managers often resent pressure from their boss to reduce their spending, and so have a hostile attitude to the entire budgeting process. This fear and hostility can exist even when senior management do not actually have a cost-cutting strategy.

Opposition to unfair targets set by senior management.

When senior managers use the budgeting process to set unrealistic and unfair performance targets for the year, their subordinates may unite in opposition to what the senior managers are trying to achieve. Senior managers should communicate and consult with the individuals affected by target-setting, and try to win their agreement to the targets they are trying to set. Targets need to be reasonable.

Sub-optimisation

There may be a risk that the planning targets for individual managers are not in the best interests of the organisation as a whole. For example, a production manager might try to budget for production targets that fully utilise production capacity. However, working at full capacity is not in the best interests of the company as a whole if sales demand is lower. It would result in a build-up of unwanted finished goods inventories. The planning process must be co-ordinated in order to avoid sub-optimal planning. In practice, however, effective co-ordination is not always achieved.

Lack of goal congruence

The behavioural problems with budgeting arise because the corporate aims of an organisation are usually not the same as the aspirations of the individuals who work for it. This is known as lack of goal congruence and leads to dysfunctional behaviour. For example, the aim of a company might be to maximise shareholder wealth, but there is no reason at all why this should be the aim of the company's employees and managers. Individuals have their own aims and ambitions, that working might (or might not) satisfy.

The potential conflict between corporate objective and the aspirations of the company's employees can become apparent in the budgeting process, when an organisation sets its targets for the next year.

The accepted wisdom is that there is a potential conflict between corporate and individual aspirations. Individuals will be inclined to do what they want for themselves, regardless of whether this is good for the organisation.

The solution to the problem should be to bring the aspirations of individual managers and other employees as closely as possible into line with the objectives of the organisation. This is the rationale for measures to motivate individuals, such as reward schemes and motivation through participation

Budget slack (budget bias)

Budget slack has been defined as 'the intentional overestimation of expenses and/or underestimation of revenue in the budgeting process' (CIMA *Official Terminology*). Managers who prepare budgets may try to over-estimate costs so that it will be much easier to keep actual spending within the budget limit. Similarly, managers may try to under-estimate revenue in their budget so that it will be easier for them to achieve their budget revenue targets. As a result of slack, budget targets are lower than they should be.

When managers are rewarded for achieving their budget targets, the motivation to include some slack in the budget is even stronger.

An additional problem with budget slack is that when a manager has slack in his spending budget, he may try to make sure that actual spending is up to the budget limit. There are two reasons for this:

- If there is significant under-spending, the manager responsible might be required to explain why.
- Actual spending needs to be close to the budget limit in order to keep the budget slack in the budget for the next year.

The problem of budget slack is particularly associated with spending on 'overhead' activities and **incremental budgeting**. One of the advantages of **zero based budgeting** is that it should eliminate a large amount of slack from budgets.

In some cases, budget bias operates the other way. Some managers might prepare budgets that are too optimistic. For example, a sales manager might budget for sales in the next financial year that are unrealistic and unachievable, simply to win the approval of senior management.

5.2 Budgeting as a bargaining process

Budgeting should be a process where an organisation prepares short-term plans that are consistent with its objectives and strategies. In practice, however, planning often involves compromises, and balancing the requirements of different long-term and short-term objectives.

As a result, budgeting can become a bargaining process between managers. The managers with the greatest power and influence are the most likely to get what they want. When money is in short supply for discretionary spending, departmental managers might compete with each other for a bigger share of the spending allocation. The budgeting process could therefore possibly become a 'power struggle' between two or more senior managers, each trying to win a larger share of the entity's resources.

In many cases, managers will make 'deals' and reach compromises on what should be included in the budget.

The bargaining process is evident perhaps in the annual round of budgeting in central government, when spending departments (health, education, social services, defence and so on) argue and negotiate with each other and with the treasury department. They try to reach agreement through bargaining on spending allowances for the next financial year.

In companies, managers might also use the budgeting process to bargain with each other and negotiate 'deals', giving way on some demands in order to get what they want in other matters.

5.3 Budgets, incentives and performance level

Many entities have reward systems based on the achievement of budget performance targets. Rewards often take the form of a cash bonus for certain individuals if actual performance reaches or exceeds the budget target. The purpose of offering rewards for performance is to give managers an incentive to achieve their targets, and to provide goal congruence between the interests of the entity and the personal interests of the manager.

Although rewards such as cash bonuses should provide incentives to improve performance, behavioural problems may arise in the negotiation of targets. This is because the performance target can be set at various different levels. Performance levels can be grouped into three broad types:

- An **'ideal' level** of performance that will only be achieved through exceptional effort, and perhaps is unachievable in practice
- The **current level** of performance, which is the average level of performance that is being achieved at the moment
- A **target level** of performance, which is more challenging that the current level but not as challenging as an ideal level.

Individuals who are offered a bonus for achieving their performance target will probably argue that current performance levels should be used, and that they should be rewarded for performance that is better than this.

Senior managers may prefer to insist on a target level of performance that is higher than current levels of achievement.

Even if it is agreed that the target performance level should be higher than the current level, there is room for negotiation (and differences of opinion) about just how difficult the target ought to be.

5.4 Motivation: participative budgets and imposed budgets

Rewards for performance are intended to motivate individuals to achieve the targets they have been set.

Another view is that individuals can be motivated to improve their performance and to set challenging budgets through their commitment to the work that they do. If individuals enjoy their work and feel committed to performing as well as possible, challenging budgets targets can be agreed and better levels of actual performance should be achieved.

Personal motivation to improve performance, it may be argued, can be achieved if individuals are allowed to:

- participate meaningfully in the budget-setting or target-setting process
- be directly involved in negotiating performance targets for the budget period.

Advantages and disadvantages of participation

The **advantages** of participative budgeting are as follows:

- Stronger motivation to achieve budget targets, because individuals are involved in setting or negotiating the targets.

- There should be much better communication of goals and budget targets to the individuals involved, and a better understanding of the target-setting process.
- Involvement by junior managers in budgeting provides excellent experience for personal development
- Better planning decisions – participation might lead to better planning decisions, because 'local' managers often have a much better detailed knowledge of operations and local conditions than senior managers.

However, there are significant **disadvantages** with participation.

- It might be difficult for junior managers to understand the overall objectives of the organisation that budgets should be designed to meet.
- The quality of planning with participation depends on the skills, knowledge and experience of the individuals involved. Participation is not necessarily beneficial in all circumstances, particularly when individuals lack experience.
- There might be a danger that budget targets will be set at a level that is not ambitious. Participation on its own is not necessarily a sufficient incentive to raise standards and targets for achievement. Individuals might try to argue that performance targets should be set at current levels of achievement.
- Senior managers might pretend to be encouraging participation, but in practice they might disregard all the proposals and ideas of their subordinates. To be effective, participation must be 'real'.
- It is generally considered that participation is a good thing, but it needs to be strictly managed by senior management to make sure optimum decisions are taken that are in line with the company's goals.

Imposed budgets

The opposite of a participative budget is an imposed budget, where senior management dictates what the budget targets should be. Imposed budgets have certain advantages:

- Less time consuming. Line managers do not have to spend time on budgeting and so are not distracted from the task of running the business.
- Senior managers may have a greater appreciation of the constraints faced by the business, such as restrictions on cash and other resources, and shareholder expectations of profits an dividends.
- It may be easier to co-ordinate departmental budgets if they are prepared together by senior management.

However the disadvantages of imposed budgets are that:

- Targets may be set at a challenging level and so are unachievable. If unachievable targets are imposed, this will lead to de-motivation.
- Opportunities for exploiting the specialist knowledge of more junior managers may be lost if they are excluded from the budget-setting process.

5.5 Behavioural aspects of budgeting: concluding remarks

This section has explained some of the behavioural problems that can arise with budgeting: the culture of senior management, the significance of incentive schemes, setting target performance levels, budget slack, the 'power struggle' for resources and spending allocations between departments, and so on.

These are problems without an obvious solution, and the seriousness of behavioural problems will vary from one entity to another.

In your examination, you may be expected to discuss some of these behavioural issues, and to suggest a possible solution to a problem that is explained in the question. However, it is strongly recommended that you should not make over-simplified and naïve comments about behavioural problems such as: 'Greater participation will improve motivation and make individuals want to work harder' or 'Individuals can be made to work harder by offering them a cash bonus', or 'Managers will always try to keep some slack in their departmental budget'.

Behavioural problems are complex. You need to understand them, but don't try telling the examiner that you know how to resolve them! Make suggestions, but don't make assertions.

CHAPTER 8

Quantitative analysis in budgeting

Contents

Cost estimation: high/low method

- Cost estimation: analysing fixed and variable costs
- High/low analysis
- High/low analysis when there is a step change in fixed costs
- High/low analysis when there is a change in the variable cost per unit

1 Cost estimation: high/low method

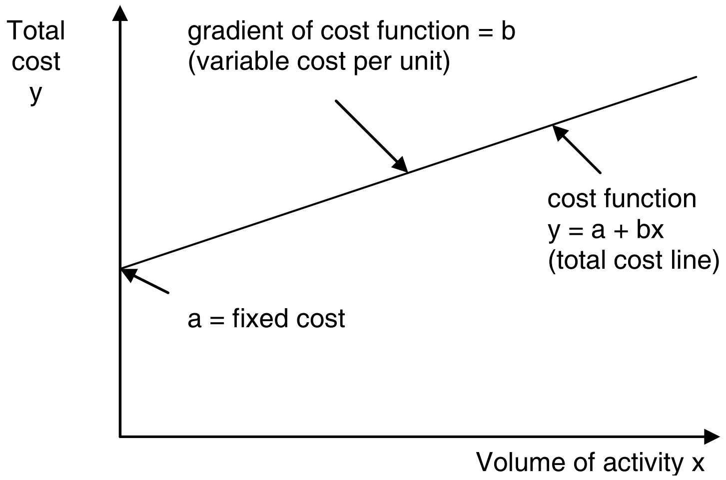
1.1 Cost estimation: analysing fixed and variable costs

For the purposes of budgeting and decision-making, it is often necessary to prepare an estimate of costs. For example, it is often necessary to estimate the total annual costs of an activity or a responsibility centre, or the total annual costs of production overheads or marketing overheads. One way of doing this is to estimate fixed costs per period and variable costs per unit of activity from historical cost data.

If total costs can be divided into fixed costs or variable costs per unit of output or unit of activity, a formula for total costs is:

$y = a + bx$
where
y = total costs in a period
x the number of units of output or the volume of activity in the period
a = the fixed costs in the period
b = the variable cost per unit of output or unit of activity.

The linear cost function equation $y = a + bx$ can be drawn on a cost behaviour graph as follows.



Two methods of estimating fixed and variable costs from historical data for total costs are:

- high/low analysis
- linear regression analysis.

1.2 High/low analysis

High/low analysis can be used to estimate fixed costs and variable costs per unit whenever:

- there are figures available for total costs at two different levels of output or activity
- it can be assumed that fixed costs are the same in total at each level of activity, and
- the variable cost per unit is constant at both levels of activity.

High/low analysis therefore uses two historical figures for cost:

- the highest recorded output level, and its associated total cost
- the lowest recorded output level, and its associated total cost.

It is assumed that these 'high' and 'low' records of output and historical cost are representative of costs at all levels of output or activity.

The **difference** between the total cost at the high level of output and the total cost at the low level of output is **entirely variable cost**. This is because fixed costs are the same in total at both levels of output.

The method

There are just a few simple steps involved in high/low analysis.

Step 1

Take the activity level and cost for:

- the highest activity level
- the lowest activity level.

Step 2

The difference between the total cost of the highest activity level and the total cost of the lowest activity level consists entirely of variable costs. This is because the fixed costs are the same at all levels of activity.

	Activity level		$
High: Total cost of	A	=	TCa
Low: Total cost of	B	=	TCb
Difference: Variable cost of (A – B) units	(A – B)	=	TCa - TCb

From this difference, we can therefore calculate the variable cost per unit of activity.

Variable cost per unit = \$(TCa – TCb)/ (A – B) units

Having calculated a variable cost per unit of activity, we can now calculate fixed costs.

Step 3

Having calculated the variable cost per unit, apply this value to the cost of either the highest or the lowest activity level. (It does not matter whether you use the high level or the low level of activity. Your calculation of fixed costs will be the same.)

Calculate the total variable costs at this activity level.

Step 4

The difference between the total cost at this activity level and the total variable cost at this activity level is the fixed cost.

Substitute in the 'low' equation	Cost
	$
Total cost of (low volume of activity)	TCb
Variable cost of (low volume of activity)	V
Therefore fixed costs per period of time	TCb - V

You now have an estimate of the variable cost per unit and the total fixed costs.

The high/low method is a simple but important technique that you need to understand. Study the following example carefully.

Example

A company has recorded the following costs in the past six months:

Month	Activity	Total cost
	Direct labour hours	$
January	5,800	40,300
February	7,700	47,100
March	8,200	48,700
April	6,100	40,600
May	6,500	44,500
June	7,500	47,100

Required

Using high/low analysis, prepare an estimate of total costs in July if output is expected to be 7,000 direct labour hours.

a

Answer

(1) Steps 1 and 2: Calculate the variable cost per hour

Take the highest level of activity and the lowest level of activity, and the total costs of each. Ignore the other data for levels of activity in between the highest and the lowest.

	Hours		$
High: Total cost of	8,200 hours	=	48,700
Low: Total cost of	5,800 hours	=	40,300
Difference: Variable cost of	2,400 hours	=	8,400

Therefore variable cost per direct labour hour = $8,400/2,400 hours = $3.50.

(2) Steps 3 and 4: Calculate fixed costs

Substitute in the 'high' equation	Cost
	$
Total cost of 8,200 hours	48,700
Variable cost of 8,200 hours (× $3.50 per hour)	28,700
Therefore fixed costs per month	20,000

(3) Using the cost analysis: Prepare a cost estimate of total costs for 7,000 hours

Cost estimate for May	Cost
	$
Fixed costs	20,000
Variable cost (7,000 hours × $3.50 per hour)	24,500
Estimated total costs	44,500

The technique can be used any time that you are given two figures for total costs, at different levels of activity or volumes of output, and you need to estimate fixed costs and a variable cost per unit.

1.3 High/low analysis when there is a step change in fixed costs

High/low analysis can be used even when there is a step increase in fixed costs between the 'low' and the 'high' activity levels, provided that the amount of the step increase in fixed costs is known.

If the step increase in fixed costs is given as a money amount, the total cost of the 'high' or the 'low' activity level should be adjusted by the amount of the increase, so that total costs for the 'high' and 'low' amounts are the same.

The high/low method can then be used in the normal way to obtain a fixed cost and a variable cost per unit. The fixed cost will be either the fixed cost at the 'high' level or at the 'low' level, depending on how you made the adjustment to fixed costs before making the high/low analysis. You can then calculate the fixed costs at the other level of activity by adding or subtracting the step change in fixed costs, as appropriate.

Example

A company has the following costs at two activity levels.

Activity	Total cost
units	$
17,000	165,000
22,000	195,000

The variable cost per unit is constant over this range of activity, but there is a step fixed cost and total fixed costs increase by $15,000 when activity level equals or exceeds 19,000 units.

Required

Using high/low analysis, calculate the total cost of 20,000 units.

Answer

There is an increase in fixed costs above 19,000 units of activity, and to use the high/low method, we need to make an adjustment for the step fixed costs. Since we are required to calculate the total cost for a volume of activity above 19,000 units, the simplest approach is to add $15,000 to the total cost of 17,000 units, so that the fixed costs of 17,000 units and 22,000 units are the same and are also the amount of fixed costs for 20,000 units.

(1) Steps 1 and 2: Calculate the variable cost per unit

	Units		$
High: Total cost	22,000 units	=	195,000
Low: Adjusted total cost: $(165,000 + 15,000)	17,000 units	=	180,000
Difference: Variable cost of	5,000 units	=	15,000

Therefore variable cost per unit = $15,000/5,000 units = $3 per unit.

(2) Steps 3 and 4: Calculate fixed costs (above 19,000 units)

Substitute in the 'high' equation	Cost
	$
Total cost of 22,000 units	195,000
Variable cost of 22,000 units (× $3 per unit)	66,000
Therefore fixed costs (above 19,000 units)	129,000

(3) Using the cost analysis: Prepare a cost estimate

Cost estimate	Cost
	$
Fixed costs (above 19,000 units)	129,000
Variable cost (20,000 units × $3)	60,000
Estimated total costs	189,000

The step increase in fixed costs is given as a percentage amount

When the step change in fixed costs between two activity levels is given as a percentage amount, the problem is a bit more complex, and to use high/low analysis we need a third figure for total cost, at another level of activity somewhere in between the 'high' and the 'low' amounts.

Total fixed costs will be the same for:

- the 'in between' activity level and
- either the 'high' or the 'low' activity level.

High/low analysis should be applied to the two costs and activity levels for which total fixed costs are the same, to obtain an estimate for the variable cost per unit and the total fixed costs at these activity levels. Total fixed costs at the third activity level (above or below the step change in fixed costs) can then be calculated making a suitable adjustment for the percentage change.

Example

A company has the following costs at three activity levels.

Activity	Total cost
units	$
5,000	180,000
8,000	240,000
11,000	276,000

The variable cost per unit is constant over this range of activity, but there is a step fixed cost and total fixed costs increase by 20% when the activity level exceeds 7,500 units.

Required
Estimate the expected total cost when the activity level is 7,000 units.

Answer

There is an increase in fixed costs above 7,500 units of activity, which means that total fixed costs and the variable cost per unit are the same for 8,000 units and 11,000 units of activity. These activity levels should be used to estimate the variable cost per unit and total fixed costs.

(1) Steps 1 and 2: Calculate the variable cost per unit

	Units		$
High: Total cost	11,000 units	=	276,000
'In-between'	8,000 units	=	240,000
Difference: Variable cost of	3,000 units	=	36,000

Therefore variable cost per unit = $36,000/3,000 units = $12 per unit.

(2) Steps 3 and 4: Calculate fixed costs (above 7,500 units)

Substitute in the 'high' equation	Cost
	$
Total cost of 11,000 units	276,000
Variable cost of 11,000 units (× $12 per unit)	132,000
Therefore fixed costs (above 7,500 units)	144,000

(3) Calculate fixed costs at activity levels below 7,500 units

Fixed costs increase by 20% above 7,500 units.
Fixed costs above 7,500 units are therefore 120% of fixed costs below 7,500 units.
Fixed costs below 7,500 units are therefore: $144,000 × (11/120) = $120,000.

(Note: Make sure that you understand the adjustment here. We do not subtract 20% from fixed costs above 7,500 units!)

(4) Using the cost analysis: Prepare a cost estimate

Cost estimate	Cost
	$
Fixed costs (below 7,500 units)	120,000
Variable cost (7,000 units × $12)	84,000
Estimated total costs	204,000

1.4 High/low analysis when there is a change in the variable cost per unit

High/low analysis can also be used when there is a change in the variable cost per unit between the 'high' and the 'low' levels of activity. The same approach is needed as for a step change in fixed costs, as described above.

When the change in the variable cost per unit is given as a percentage amount, a third 'in between' estimate of costs should be used, and the variable cost per unit will be the same for:

- the 'in between' activity level and
- either the 'high' or the 'low' activity level.

High/low analysis may be applied to the two costs and activity levels for which unit variable costs are the same, to obtain an estimate for the variable cost per unit and the total fixed costs at these activity levels. The variable cost per unit at the third activity level can then be calculated making a suitable adjustment for the percentage change.

Example

A company has the following costs at three activity levels.

Activity	Total cost
units	$
20,000	300,000
25,000	320,000
30,000	356,000

The fixed costs are constant over this range of activity, but there is a 10% reduction in the variable cost per unit above 24,000 units of activity. This reduction applies to all units of activity, not just the additional units above 24,000.

Required
Estimate the expected total cost when the activity level is 22,000 units.

Answer

The variable cost per unit is the same for both 25,000 units and 30,000 units. High/low analysis should therefore be applied to these activity levels.

(1) Calculate the variable cost per unit above 24,000 units

	Units		$
High: Total cost	30,000 units	=	356,000
'In-between'	25,000 units	=	320,000
Difference: Variable cost of	5,000 units	=	36,000

Therefore variable cost per unit = $36,000/5,000 units = $7.20 per unit.

(2) Calculate the variable cost per unit below 24,000 units

The variable cost per unit above 24,000 units is 90% of the cost below 24,000 units. The variable cost per unit below 24,000 units is therefore (× 100/90) of the cost above 24,000 units.
Variable cost per unit below 24,000 units = $7.20 × 100/90 = $8

(3) Calculate fixed costs

Substitute in the 'low' equation	Cost
	$
Total cost of 20,000 units	300,000
Variable cost of 20,000 units (× $8 per unit)	160,000
Therefore fixed costs (above 7,500 units)	140,000

(4) Using the cost analysis: Prepare a cost estimate

Cost estimate for 22,000 units	Cost
	$
Fixed costs	140,000
Variable cost (22,000 units × $8)	176,000
Estimated total costs	316,000

Cost estimation: linear regression analysis

- The purpose of linear regression analysis
- The linear regression formulae
- Applying the linear regression formulae

2 Cost estimation: linear regression analysis

2.1 The purpose of linear regression analysis

Linear regression analysis is a statistical technique for calculating a line of best fit from a set of data:

y = a + bx

The data is in 'pairs', which means that there are a number of different values for x, and for each value of x there is an associated value of y in the data.

Linear regression analysis can be used to estimate fixed costs and the variable cost per unit from historical data for total costs. It is an alternative to the high-low method.

Linear regression analysis can also be used to predict future sales by projecting the historical sales trend into the future (on the assumption that sales growth is rising at a constant rate, in a 'straight line').

Regression analysis and high-low analysis compared

There are important differences between linear regression analysis and the high-low method.

- High-low analysis uses just two sets of data for x and y, the highest value for x and the lowest value for x. Regression analysis uses as many sets of data for x and y as are available.
- Because regression analysis calculates a line of best fit for all the available data, it is likely to provide a more reliable estimate than high-low analysis for the values of a and b.
- In addition, regression analysis can be used to assess the extent to which values of y depend on values of x. For example, if a line of best fit is calculated that estimates total costs for any volume of production, we can also calculate the extent to which total costs do seem to be linked (or 'correlated') to the volume of production. This is done by calculating a **correlation co-efficient**, which is explained later.
- Regression analysis uses more complex arithmetic than high-low analysis, and a calculator or small spreadsheet model is normally needed

In summary, linear regression analysis is a better technique than high-low analysis because:

- it is more reliable and
- its reliability can be measured.

2.2 The regression analysis formulae

The formulae for estimating costs using regression analysis are provided in a formulae sheet in your examination. You might be required to apply the formulae to data provided in an examination question.

Linear regression analysis is used to calculate values for a and b in the linear cost equation: y = a + bx.

The linear regression formulae for calculating a and b are shown below. The number of pairs of data that are used in the calculation is n.

The regression analysis formulae are as follows. They will be given to you in your examination, so you do not need to learn them. However, you may be required to use them:

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n}$$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

where:
n = the number of pairs of data used for x and y
x, y represent the values of x (volume of activity or output) and y (total cost)

The value of 'b' is an item in the formula for calculating 'a'. It is therefore necessary to calculate 'b' first before calculating 'a'.

Understanding the formulae

These formulae might seem complicated, but they involve the application of fairly simple arithmetic.

- You should think of the pairs of data as a list of values set out in two columns, with one column for the values of x and the second column for the associated values of y. Typically x represents the volume of activity and y is the total cost.
- You should then prepare two more columns.
- There should be an additional column for x^2. Calculate the square of each value of x in the x column and write the answer in the x^2 column.
- The fourth column is for xy. For each pair of data for x and y, multiply the value of x by the value of y, and enter the answer in the xy column.
- You must then add up the totals for each of the four columns. $\sum x$ is the total of all the values in the x column. $\sum y$ is the total of all the values in the y column. $\sum x^2$ is the total of all the values in the x^2 column and $\sum xy$ is the total of all the values in the xy column.

- You now have all the values you need to calculate a value for b in the formula y = a + bx.
- The only other item you might not be sure about is $(\sum x)^2$. This is not the same as $\sum x^2$. It is the square of the value for $\sum x$.
- Having calculated a value for b, you can then use the formula for calculating the value of a: this includes the value for b, which is why you need to calculate b first.

2.3 Applying the regression analysis formulae

The formulae might seem complicated, but they are actually fairly straightforward provided that you understand the meaning of the $\sum$ items in the formulae, and remember that n is the number of pairs of data used to make the estimate. Study the following example carefully. It uses the same data as one of the previous examples for the high-low method.

Example

A company has recorded the following costs in the past six months:

Month	Activity	Total cost
	Direct labour hours, in 000	$000
January	5.8	40.3
February	7.7	47.1
March	8.2	48.7
April	6.1	40.6
May	6.5	44.5
June	7.5	47.1

Required

Using linear regression analysis, prepare an estimate of total costs in July if output is expected to be 7,000 direct labour hours.

Answer

The starting point is to draw a table showing the values of x (output) and y (total cost). For each value of x and y, you should calculate the value of:

- x^2 and
- xy.

For reasons to be explained later, the value of y^2 will also be calculated here.

There are six pairs of data, so there should be six different values for x, y, x^2, xy and y^2.

Add the figures in each column to obtain totals for:

- $\sum x$ (= the sum of the values of x)
- $\sum y$ (= the sum of the values of y)
- $\sum x^2$

- $\sum xy$
- $\sum y^2$. (The reason for calculating $\sum y^2$ will be explained later.)

Month	Output	Total cost			
	000 units	$000			
	x	y	x^2	xy	y^2
January	5.8	40.3	33.64	233.74	1,624.09
February	7.7	47.1	59.29	362.67	2,218.41
March	8.2	48.7	67.24	399.34	2,371.69
April	6.1	40.6	37.21	247.66	1,648.36
May	6.5	44.5	42.25	289.25	1,980.25
June	7.5	47.1	56.25	353.25	2,218.41
	41.8	268.3	295.88	1,885.91	12,061.21
	$= \sum x$	$= \sum y$	$= \sum x^2$	$= \sum xy$	$= \sum y^2$

There are six pairs of data, so n = 6.

We now have all the figures we need to calculate values for 'a' and 'b, starting with 'b'.

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

$$b = \frac{6\,(1{,}885.91) - (41.8)(268.3)}{6\,(295.88) - (41.8)^2} = \frac{11{,}315.46 - 11{,}214.94}{1{,}775.28 - 1{,}747.24} = \frac{100.52}{28.04}$$

$$b = 3.585$$

This is the estimate of the variable cost per unit. The value of 'b' is used to calculate a value for 'a', as follows.

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n}$$

$$a = \frac{268.3}{6} - \frac{3.585\,(41.8)}{6} = 44.72 - 24.98$$

$$a\ (\text{in } \$000) = 19.74$$

Answer (a)

Estimated fixed costs each month = a = $19,740

Estimated variable cost per unit = b = $3.585

Therefore, linear cost function, y, is estimated to be:

y = 19,740 + 3.585x

For simplicity, this could be rounded to:

y = 19,700 + 3.6x.

Answer (b)

Using y = 19,700 + 3.6x, when monthly output is expected to be 7,000 hours, the expected total costs will be:

	$
Fixed	19,700
Variable (7,000 × $3.6)	25,200
	44,900

Correlation and the correlation coefficient

- Correlation
- Degrees of correlation
- Correlation coefficient, r
- Coefficient of determination, r^2

3 Correlation and the correlation coefficient

3.1 Correlation

Linear regression analysis can be applied to any sets of data where the data is in pairs (x and y). It could be used, for example, to calculate a line of best fit for total weekly costs of an activity by taking pairs of data for total weekly costs (= y) and the associated values for the activity. However, the activity level might be any of the following:

- units of output each week, if it is assumed that weekly costs vary with the volume of output produced
- direct labour hours each week, if it is assumed that weekly costs vary with the number of direct labour hours worked
- machine hours operated each week, if it is assumed that weekly costs vary with the number of machine hours.

Which activity is the best one to choose as 'x'?

Since a line of best fit can be calculated between any two variables using regression analysis, important questions are:

- How can we assess the reliability of the line of best fit?'
- How do we know whether our choice of activity as 'x' is a good one?

The answer to both questions is that the reliability of the regression formula can be assessed using a statistic called the coefficient of correlation.

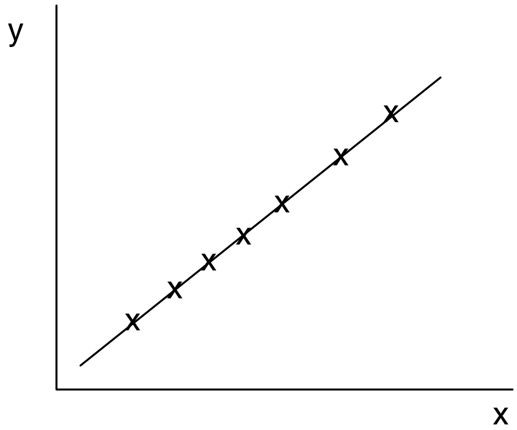
Correlation is a measure of the strength of the relationship between two variables. Variables are said to be correlated if a change in one variable results in a change in the other variable.

If you plot a graph of the data relating to two variables, you should be able to see if any visible relationship exists between them (such a graph is known as a scattergraph or scatterchart). If a visible relationship is seen to exist, the data on the graph can be plotted to show the 'line of best fit'. The 'line of best fit' is of the form y = a + bx (linear cost function) and indicates that a 'possible' linear relationship exists between two variables.

3.2 Degrees of correlation

The following scattergraphs show the different degrees of correlation that may be seen to exist between two variables.

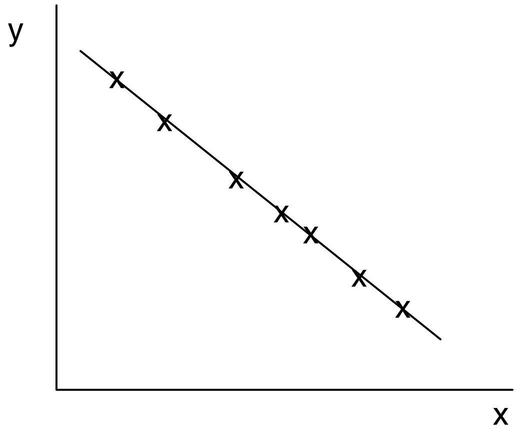
Perfect positive correlation



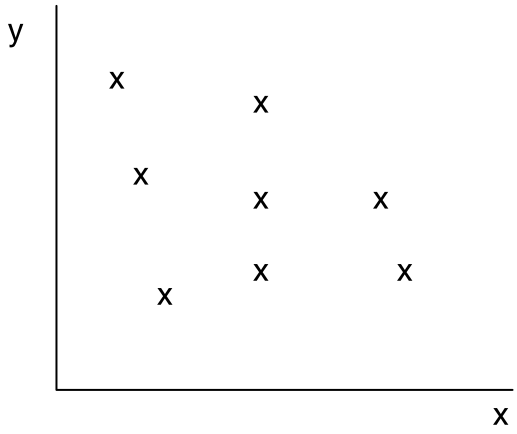
Perfect correlation is seen to exist when all the data points plotted lie in an exact straight line and a linear relationship exists between the two variables.

Perfect positive correlation means that high values of are variable are associated with high values of another variable. Alternatively, low values of one variable may be associated with low values of another variable.

Perfect negative correlation



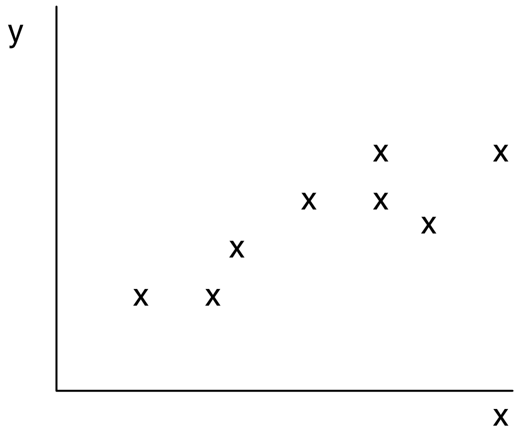
Perfect negative correlation is seen to exist when all the data points plotted lie in an exact straight line and that high values of one variable are associated with low values of another variable. Alternatively, low values of one variable may be associated with high value of another variable.



No correlation (uncorrelated)

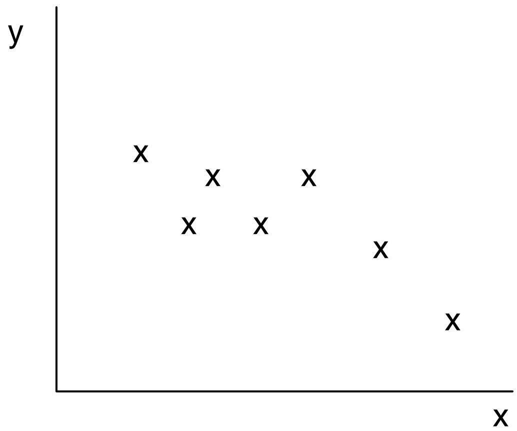
'Uncorrelated' means that no correlation is seen to exist between the variables.

Positive correlation (but not perfect correlation)



Positive correlation means that there appears to be some correlation between the values of y and x, and in general the value of y increases as the value of x increases. However, the correlation is not perfect because all the data does not lie exactly on a straight line on the scattergraph.

Negative correlation



Negative correlation means that a relationship exists between two variables, and the value of y declines as the value of x increases. However, the correlation is not perfect.

As an alternative to drawing a scattergraph to see whether a visible relationship exists between the two variables x and y, the correlation between them can be measured by calculating a **correlation coefficient**.

3.3 Correlation coefficient r

An advantage of using the regression analysis method is that the reliability of the estimates can be assessed statistically, by calculating a correlation coefficient.

The formula for the correlation coefficient (r) will be given to you in the examination.

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - (\sum x)^2\right)\left(n\sum y^2 - (\sum y)^2\right)}}$$

This formula might seem difficult, but it is fairly similar to the formula for calculating 'b' in the linear cost equation. The only additional value that we need to calculate the correlation coefficient is a value for $[n\sum y^2 - (\sum y)^2]$.

- If you look back at the previous example, you will see that the value for $\sum y^2$ has already been calculated. In the example, there is a separate column for y^2. Calculate the square of each value of y in the y column and enter it in the same row in the y^2 column. Then add up all the values of y^2 in the y^2 column to get $\sum y^2$.
- $(\sum y)^2$ is a different value. It is the square of the value for $\sum y$.

The value of the correlation coefficient, r, in the example in paragraph 2.3 is therefore calculated as follows. Remember that most of the values for the formula have been calculated in paragraph 2.3 as parts of the formula for calculating the value of b.

$$r = \frac{100.52}{\sqrt{(28.04)[6(12{,}061.21) - (268.3)^2]}} = \frac{100.52}{\sqrt{(28.04)(382.37)}} = \frac{100.52}{103.55} = +0.97$$

The correlation coefficient r is + 0.97.

Significance of the correlation coefficient

The value of the correlation coefficient must always be in the range – 1 to + 1.

- A value of – 1 indicates that there is perfect negative correlation between the values for y and the values for x that have been used in the regression analysis estimates. Perfect negative correlation means that all the values for x and y, plotted on a graph, would lie on a straight downward-sloping line.

- A value of + 1 indicates that there is perfect positive correlation between the values for y and the values for x that have been used in the regression analysis estimates. Perfect positive correlation means that all the values for x and y, plotted on a graph, would lie on a straight upward-sloping line.
- A value of r = 0 indicates no correlation at all between the values of x and y.

For cost estimation, a value for r close to + 1 would indicate that the cost estimates are likely to be very reliable.

As a general guide, a value for r between + 0.90 and + 1 indicates good correlation between the values of x and y, suggesting that the formula for costs can be used with reasonable confidence for cost estimation.

If you calculate a value for r that is more than +1 or is a greater negative value than – 1, your calculation will be wrong.

3.4 Coefficient of determination r^2

The square of the correlation coefficient, r^2, is called the coefficient of determination. The value of r^2 shows how much the variations in the value of y, in the data used to calculate the regression analysis formula, can be explained by variations in the value of x.

Significance of coefficient of determination

The value of the coefficient of determination must always be in the range 0 to +1.

- If the value of r is + 0.70, this means that on the basis of the data used in the regression analysis formula, 0.49 or 49% (= 0.70^2) of variations in the value of y can be explained by variations in the value of x.
- Similarly if the value of r is – 0.80, this means that on the basis of the data used in the regression analysis formula, 0.64 or 64% (= 0.80^2) of variations in the value of y can be explained by variations in the value of x. Since r is negative, this means that y falls in value as the value of x increases.

In the example above, where r = + 0.97, we can say that from the data used to produce a formula for total costs, 94.09% (0.97 × 0.97) of the variations in total cost can be explained by variations in the volume of output. This would suggest that the formula obtained for total costs is likely to be fairly reliable for estimating future costs for any given (budgeted) volume of production.

The coefficient of correlation and the coefficient of determination can therefore be used to give a statistical measurement to the reliability of estimates of y from a given value for x, using a line of best fit that has been calculated by linear regression analysis. As you might imagine, this can be a useful item of management information for the purpose of forecasting or planning.

Time series analysis

- The nature of a time series
- Linear regression analysis and forecasting a trend line
- Moving averages
- Calculating seasonal variations
- Using the trend line and seasonal variations to make forecasts
- Problems with seasonal variation analysis

4 Time series analysis

4.1 The nature of a time series

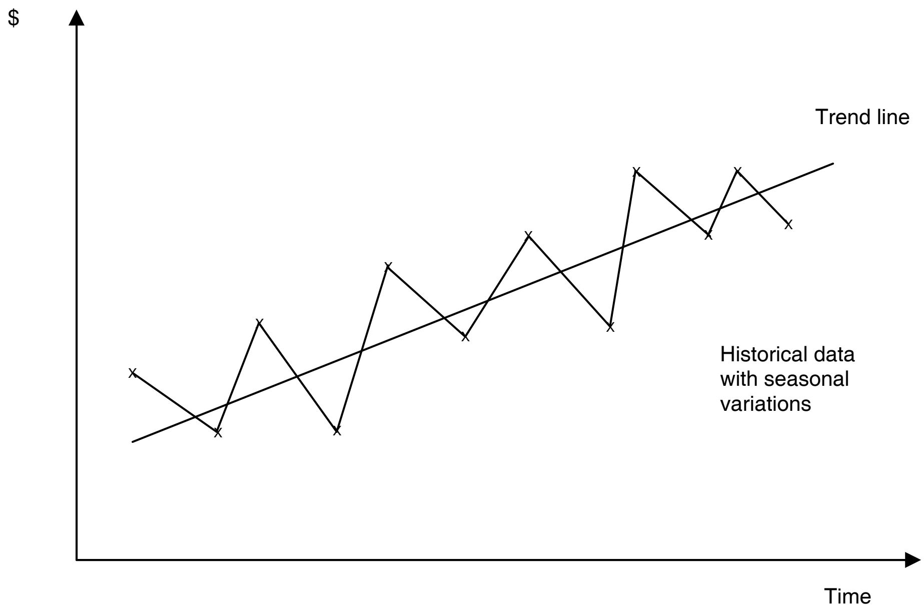
A time series is a record of data over a period of time. In budgeting, an important time series is the amount of annual sales revenue (or sales revenue per month or revenue per quarter) over time. Historical data about sales might be used to predict what sales will be in the future, in the budget period, when it is assumed that there is an upward or downward trend over time.

Trends might be identified over time for other aspects of a business, such as the number of people employed by the entity or the number of customer orders handled.

There are several techniques that may be used to predict a future from historical data for a time series. With these techniques, it is assumed that:

- There is an underlying trend, which is either an upward trend or downward trend.
- There may be seasonal variations (or monthly variation or daily variations) around the trend line.

The diagram below shows a trend line with seasonal variations above and below the trend line. The general trend in this diagram is up and the trend can be shown as a straight line. However the actual value in each time period is above or below the trend, because of the seasonal variations.



Analysing a time series

There are two aspects to analysing a time series from historical data:

- Estimating the trend line
- Calculating the amount of the seasonal variations (or monthly variations or daily variations).

The time series can then be used to make estimates for a future time period, by calculating a trend line value and then either adding or subtracting the appropriate seasonal variation for that time period.

Two methods of calculating a trend line are:

- Linear regression analysis
- Moving averages.

Methods of calculating seasonal variations are explained later.

4.2 Linear regression analysis and forecasting a trend line

Linear regression analysis can be used in forecasting, if it can be assumed that there has been a linear trend in the past, and this same linear trend will continue into the future. For example, if sales revenue has grown at a fairly constant rate in the past, it might be assumed that sales will continue to grow at the same rate in the future. Linear regression analysis can be used to establish a time series and forecast future sales.

Exactly the same method is used in forecasting as for estimating fixed and variable costs. The trend line is a formula y = a + bx, where x is the year or month.

To simplify the arithmetic for analysing the historical data, you should number the years 1, 2, 3, 4 and so on (or even start at year 0, and number the years 0, 1, 2, 3 and so on). This is much easier than using the actual numbers for the years 2004, 2005, 2006, 2007, 2008, 2009 and so on.

Linear regression analysis is a useful method for analysing a time series, but only if:

- a straight line trend can be assumed, and
- there are no seasonal variations in the historical data..

4.3 Moving averages

Moving averages are an alternative method to linear regression analysis for estimating a trend line, particularly when there are seasonal variations in the data. Moving averages are calculated as follows:

- **Step 1**. Decide the length of the cycle. The cycle is a number of days or weeks, or seasons or years. For example, the cycle will be seven days when historical data is collected daily for each day of the week. The cycle will be one year when data is collected monthly for each month of the year, or quarterly for each season.
- **Step 2**. Use the historical data to calculate a series of moving averages. A moving average is the average of all the historical data in one cycle. For example, suppose that historical data is available for daily sales over a period Day 1 – Day 21, and there are seven days of selling each week. A moving average can be calculated for Day 1 – Day 7. Another moving average can be calculated for Day 2 – Day 8. Another moving average can be calculated for Day 3 – Day 9, and so on up to a moving average for Day 15 – Day 21.
- **Step 3**. Match each moving average with an actual time period. The moving average should be matched with the middle time period of the cycle. For example a moving average for Day 1 – Day 7 is matched with Day 4, which is the middle of the period. Similarly, a moving average for Day 2 – Day 8 is matched with Day 5, and a moving average for Day 15 – Day 21 is matched with Day 18.
- **Step 4**. Use the moving averages (and their associated time periods) to calculate a trend line, using simple averaging, the high low method or linear regression analysis. It is also often useful to plot the data on a graph and extend a line of best fit.

Example

A company operates for five days each week. Sales data for the most recent three weeks are as follows:

Sales	**Monday** units	**Tuesday** units	**Wednesday** units	**Thursday** units	**Friday** units
Week 1	78	83	89	85	85
Week 2	88	93	99	95	95
Week 3	98	103	109	105	105

For convenience, it is assumed that Week 1 consists of Days 1 – 5, Week 2 consists of Days 6 – 10, and Week 3 consists of Days 11 – 15.

This sales data can be used to estimate a trend line. A weekly cycle in this example is 5 days, so we must calculate moving averages for five day periods, as follows:

Period	Middle day		Moving average
Days 1 – 5	Day 3	[78 + 83 + 89 + 85 + 85] /5	84
Days 2 – 6	Day 4	[83 + 89 + 85 + 85 + 88] /5	86
Days 3 – 7	Day 5	[89 + 85 + 85 + 88 + 93] /5	88
Days 4 – 8	Day 6	[85 + 85 + 88 + 93 + 99] /5	90
Days 5 – 9	Day 7	[85 + 88 + 93 + 99 + 95] /5	92
Days 6 – 10	Day 8	[88 + 93 + 99 + 95 + 95] /5	94
Days 7 – 11	Day 9	[93 + 99 + 95 + 95 + 98] /5	96
Days 8 – 12	Day 10	[99 + 95 + 95 + 98 + 103] /5	98
Days 9 – 13	Day 11	[95 + 95 + 98 + 103 + 109] /5	100
Days 10 – 14	Day 12	[95 + 98 + 103 + 109 + 105] /5	102
Days 11 – 15	Day 13	[98 + 103 + 109 + 105 + 105]/5	104

In this example, all the moving average figures lie on a perfect straight line. It can be seen that each day the trend increases by 2. If x = the day number, the formula for the trend can be calculated by taking any day, say day 12

$a + 2 \times 12 = 102$ so $a = 78$.

The formula is daily sales = 78 + 2x.

This trend line can be used to calculate the 'seasonal variations' (in this example the daily variations in sales above or below the trend).

Moving averages and trend line when there is an even number of seasons

When there is an even number of seasons in a cycle, the moving averages will not correspond to an actual season. When this happens it is necessary to take moving averages of the moving averages, which will correspond to an actual season of the year.

Example

The following sales figures have been recorded for a company, where sales are known to fluctuate with the season of the year. There are four seasons (four quarters) in the year. Historical data for quarterly sales is shown in the table below.

Sales	Quarter 1	Quarter 2	Quarter 3	Quarter 4
	\$000	\$000	\$000	\$000
Year 1	20	24	27	31
Year 2	35	39	44	47
Year 3	49	56	60	64

These quarters for the three years will be called Quarter 1 – Quarter 12. There are four seasons in the annual cycle, so moving average values for each quarter are calculated as follows:

Period	Middle quarter	Moving average	Moving average of moving average (average of 2)
Quarters 1 – 4	Quarter 2.5	25.50	
	Quarter 3		27.375
Quarters 2 – 5	Quarter 3.5	29.25	
	Quarter 4		31.125
Quarters 3 – 6	Quarter 4.5	33.00	
	Quarter 5		35.125
Quarters 4 – 7	Quarter 5.5	37.25	
	Quarter 6		39.250
Quarters 5 – 8	Quarter 6.5	41.25	
	Quarter 7		43.000
Quarters 6 – 9	Quarter 7.5	44.75	
	Quarter 8		46.875
Quarters 7 – 10	Quarter 8.5	49.00	
	Quarter 9		51.000
Quarters 8 – 11	Quarter 9.5	53.00	
	Quarter 10		55.125
Quarters 9 – 12	Quarter 10.5	57.25	

The moving averages in the right hand column correspond with an actual season. These moving averages are used to estimate the trend line and the seasonal variations.

4.4 Calculating seasonal variations

The trend line on its own is not sufficient to make forecasts for the future. We also need estimates of the size of the 'seasonal' variation for each of the different seasons. In the two examples above:

- In the first example we need an estimate of the amount of the expected daily variation in sales, for each day of the week.
- In the second example we need to calculate the variation above or below the trend line for each season or quarter of the year.

A 'seasonal variation' can be measured from historical data as the difference between the actual historical value for the time period, and:

- the corresponding moving average value, where moving averages are used, or
- the corresponding straight line value for the trend line, where linear regression analysis is used.

Either of two assumptions might be made about seasonal variations.

- The **additive assumption**. This assumption is that the sum of seasonal variations above and below the trend line in each cycle adds up to zero. Seasonal variations below the trend line have a negative value and variations above the trend line have a positive value. Taking all the seasonal variations together in one cycle, they will add up to 0.
- The **proportional assumption**. This assumption is that the actual value in each season can be expressed as a proportion of the trend line value. For example, sales in Quarter 1 might be 120% of the trend line value, sales in Quarter 2 95% of the trend line value, sales in Quarter 3 103% of the trend line value and sales in Quarter 4 85% of the trend line value. When the proportional assumption is used for seasonal variations, the seasonal variations in the cycle multiplied together must = 1. In the example above, $1.20 \times 0.95 \times 1.03 \times 0.85 = 1.0$ (allowing for a small rounding error).

Estimating seasonal variations: the additive model

The seasonal variation for each season (or daily variation for each day) is estimated as follows, when the additive assumption is used:

- Use the moving average values that have been calculated from the historical data, and the corresponding historical data. ('actual' data) for the same time period.
- Calculate the difference between the moving average value and the actual historical figure for each time period. This is a seasonal variation. You will now have a number of seasonal variations, covering several weekly or annual cycles.
- Group these seasonal variations into the different seasons of the year (or days of the week). You will now have several seasonal variations for each day of the week or season of the year.
- For each season (or day), calculate the average of these seasonal variations.
- This average seasonal variation for each day of the week or season of the year is used as the seasonal variation for the purpose of forecasting. However, if the seasonal variations for the cycle do not add up to zero, adjust the seasonal variations so that they do add up to zero.

The seasonal variations can then be used, with the estimated trend line, to make forecasts for the future.

Example

Using the example above of the trend line for daily sales, the seasonal variations are calculated as follows:

Middle day	**Day of the week**	**Moving average value**	**Actual sales**	**Variation (Actual – Moving average)**
Day 3	Wednesday	84	89	+ 5
Day 4	Thursday	86	85	- 1
Day 5	Friday	88	85	- 3
Day 6	Monday	90	88	- 2
Day 7	Tuesday	92	93	+ 1
Day 8	Wednesday	94	99	+ 5
Day 9	Thursday	96	95	- 1
Day 10	Friday	98	95	- 3
Day 11	Monday	100	98	- 2
Day 12	Tuesday	102	103	+ 1
Day 13	Wednesday	104	109	+ 5

The seasonal variation (daily variation) is now calculated as the average seasonal variation for each day, as follows:

Variation	**Monday** units	**Tuesday** units	**Wednesday** units	**Thursday** units	**Friday** units
Week 1			+ 5	- 1	- 3
Week 2	- 2	+ 1	+ 5	- 1	- 3
Week 3	- 2	+ 1	+ 5		
Average	- 2	+ 1	+ 5	- 1	- 3

Points to note

(1) In this example, the average seasonal variation for each day of the week is exactly the same as the actual seasonal variations. This is because the historical data in this example produces a perfect trend line.

(2) The total of the seasonal variations for each day of the week is 0. (- 2 + 1 + 5 – 1 – 3 = 0.) When seasonal variations are applied to a straight-line trend line, they must always add up to zero. If the seasonal variations did not add up to 0, the trend line would not be straight. It would 'curve' up or down, depending on whether the sum of the seasonal variations is positive or negative.

(3) If the total of the seasonal variations over a cycle do not add up to 0, the variations should be adjusted so that they do add up to 0 – for example by adding 1 or subtracting 1 from the variation for the seasons with the largest variations.

Estimating seasonal variations with the proportional model

When a proportional model is used to calculate seasonal variations, rather than the additive model, the seasonal variations for each time period are calculated by dividing the actual data by corresponding moving average or trend line value.

Example

Using the previous example for quarterly sales, actual sales and the corresponding moving average value were as follows:

Quarter	Actual sales in the quarter	Moving average value of sales	Seasonal variation: actual sales as a proportion of the moving average
Year 1, Quarter 3	27	27.375	0.986
Year 1, Quarter 4	31	31.125	0.996
Year 2, Quarter 1	35	35.125	0.996
Year 2, Quarter 2	39	39.250	0.994
Year 2, Quarter 3	44	43.000	1.023
Year 2, Quarter 4	47	46.875	1.003
Year 3, Quarter 1	49	51.000	0.961
Year 3, Quarter 2	56	55.125	1.016

Variation	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Year 1			0.986	0.996
Year 2	0.996	0.994	1.023	1.003
Year 3	0.961	1.016		
Average	0.978	1.004	1.004	0.999
Adjust to	0.98	1.01	1.01	1.00

In this example, the seasonal variations are very small. The average variation for each quarter is found by multiplying the values for the variations, and taking the nth root. In quarter 1 for example, the average variation is calculated as $\sqrt{}$ (0.996 × 0.961) = 0.978.

The adjustment is made so that the seasonal variations, when multiplied together, come to 1.0.

In this example, the seasonal variations are very small.

4.5 Using the trend line and seasonal variations to make forecasts

When the trend line and seasonal variations have been estimated, we can make forecasts for the future. In the example above of daily sales, suppose that we wanted to forecast sales in units each day during Week 4 (days 16 – 20) and the trend line is 78 + 2x.

The 'seasonal variations' (daily variations) are as calculated above: - 2, + 1, + 5, - 1 and - 3.

The daily sales forecasts are calculated as follows:

Day		**Trend line value (78 + 2x)**	**Seasonal variation**	**Forecast sales (units)**
16	Monday	110	- 2	108
17	Tuesday	112	+ 1	113
18	Wednesday	114	+ 5	119
19	Thursday	116	- 1	115
20	Friday	118	- 3	115

4.6 Problems with seasonal variation analysis

There are two problems with using this technique to make forecasts with seasonal variations.

(1) The historical data will not provide a perfect trend line. The trend line that is estimated with the historical data is a 'best estimate', not a perfect estimate.

(2) It is assumed that seasonal variations are a constant value, whereas they might be changing over time.

(3) Forecasts using estimated trends and seasonal variations are based on the assumptions that the past is a reliable guide to the future. This assumption may be incorrect. However, forecasts must be made; otherwise it is impossible to make plans beyond the very short term.

Estimates based on judgement and experience

There is an argument that instead of using models to forecast future sales (or make any other time series forecast), it might be better to rely on the judgement and experience of management.

Management will be aware of changes in the business environment or in the market that might affect results in the future, and time series analysis based on moving averages and seasonal variations would not make any allowance for these expected changes.

However, the drawback to relying on management judgement is that managers can make incorrect guesses.

The learning curve

- Learning curve theory: the learning effect
- The learning curve model
- Graph of the learning curve
- Formula for the learning curve
- Conditions for the learning curve to apply

5 The learning curve

5.1 Learning curve theory: the learning effect

When a team of workers begins a skilled task for the first time, and the task then becomes repetitive, they will probably do the job more quickly as the workers learn the task and so become more efficient. They will find quicker ways of performing tasks, and will become more efficient as their knowledge and understanding increase. This improvement in efficiency through experience is called the learning effect.

When a skilled task is well-established and has been in operation for a long time, the learning effect wears out, and the time to complete the task eventually becomes the same every time the task is subsequently carried out.

When the average time to produce an additional unit becomes constant, a '**steady state'** has been reached.

However, during the learning period, the time to complete each subsequent task can fall by a very large amount and the earning effect can be substantial.

The learning effect (and learning curve) was first discovered in the US during the 1940s, in aircraft manufacture. It probably still applies today in aircraft manufacture. Aircraft manufacture is a highly-skilled task, where:

- the skill of the work force is important, and
- the labour time is a significant element in production resources and production costs.

Where the learning effect is significant, it has implications for:

- costs of completing the task, and
- budgeting/forecasting production requirements and production costs
- pricing the output so as to make a profit.

Prices charged to the customer can allow for the cost savings that will be made because of the learning effect

5.2 The learning curve model

The learning effect can be measured mathematically, and shown as a learning curve.

This learning curve model was developed from actual observations and analysis in the US aircraft industry.

The learning curve is measured as a percentage learning effect. For example, for a particular task, there might be an 80% learning curve effect, or a 90% learning curve effect, and so on.

The mathematical significance of a learning curve

When there is a b% learning curve for the manufacture of a product, this means that when cumulative output of the product doubles, the average time to produce all the units made so far (the cumulative total produced to date) is b% of what it was before.

For example, when there is an 80% learning curve, the cumulative average time to produce units of an item is 80% of what it was before, every time that output doubles.

- The **cumulative average time per unit** is the average time for all the units made so far, from the first unit onwards.
- This means, for example, that if an 80% learning curve applies, the average time for the first two units is 80% of the average time for the first unit.
- Similarly, the average time for the first four units is 80% of the average time for the first two units.

Example

The time to make a new model of a sailing boat is 100 days. It has been established that in the boat-building industry, there is an 80% learning curve.

Required: Calculate:

(a) the cumulative average time per unit for the first 2 units, first 4 units, first 8 units and first 16 units of the boat

(b) the total time required to make the first 2 units, the first 4 units, the first 8 units and the first 16 units

(c) the additional time required to make the second unit, the 3rd and 4th units, units 5 – 8 and units 9 – 16.

Answer

Total units (cumulative)	Cumulative average time per unit	Total time for all units	Incremental time for additional units	Average time for additional units
	days	days	days	days
1	100	100.00	100.00	
2 (× 80%)	80	160.00	60.00	60.00
4 (× 80%)	64	256.00	96.00	48.00
8 (× 80%)	51.2	409.60	153.60	38.40
16 (× 80%)	40.96	655.36	245.76	30.72

Example

The first unit of a new model of machine took 1,600 hours to make. A 90% learning curve applies. How much time would it take to make the first 32 units of this machine?

Answer

Average time for the first 32 units = 1,600 hours × 90% × 90% × 90% × 90% × 90%
= 944.784 hours

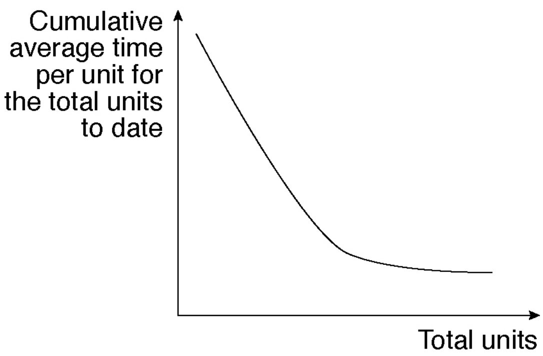
Total time for the first 32 units = 32 × 944.784 hours = 30,233 hours.

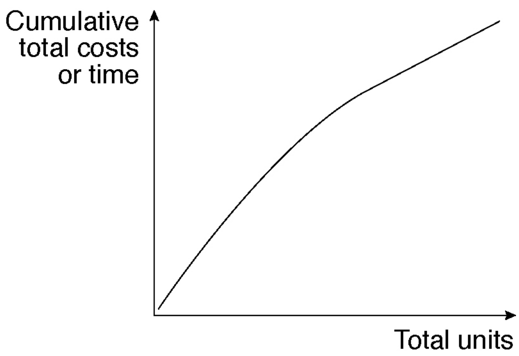
5.3 Graph of the learning curve

The learning curve can be shown as a graph. Two graphs are shown below.

The left-hand graph shows the cumulative average time per unit. This falls rapidly at first, but the learning effect eventually ends and the average time for each additional unit eventually becomes constant (a standard time).

The right hand graph shows how total costs increase. The total cost line is a curved line initially, because of the learning effect.





5.4 Formula for the learning curve

The learning curve is represented by the following formula (mathematical model):

Learning curve: $y = ax^b$

where
y = the cumulative average time per unit for all units made
x = the number of units made so far (cumulative number of units)
a = the time for the first unit
b = the learning factor.

This formula is given to you in the examination. You do not have to learn it, but you must be able to use it.

$$\text{The learning factor b} = \frac{\text{Logarithm of learning rate}}{\text{Logarithm of 2}}$$

The learning rate is expressed as a decimal, so if the learning curve is 80%, the learning factor is: (logarithm 0.80/logarithm 2)

To use this formula you must be able to calculate logarithms. Make sure that your calculator has a function for calculating logarithms (a 'log' button) and that you know how to use it.

The logarithm of a number is the number expressed as a value to the power of 10. For example the logarithm of 5 is 0.69897 because 5 is ten to the power 0.69897, $10^{0.69897}$.

- The logarithm of 2 is 0.3010
- The logarithm of 1 = 0.0000
- The logarithm of a learning rate will always be a minus value, because the learning is always less than 1 and its logarithm is less than 0.0000.
- For example if the learning rate is 70%, the logarithm of 0.70 is – 0.1549, and $10^{-0.1549}$ is the same as $1/10^{0.1549}$.

Example

If there is an 80% learning curve, the learning factor is calculated as follows:

$$\frac{\text{Logarithm 0.80}}{\text{Logarithm 2}} = \frac{-0.09691}{0.30103} = -0.32193$$

The learning curve formula is therefore: $y = ax^{-0.32193}$

It might help to remember that $x^{-0.32913}$ is another way of writing $\frac{1}{x^{0.32193}}$

Going back to the previous example, if the first unit takes 100 days and an 80% learning curve applies, the cumulative average time to produce the first 8 units can be calculated as:

$$y = 100 \times \frac{1}{8^{0.32193}}$$

= 100 (0.512)

= 51.20 days

Example

It will take 500 hours to complete the first unit of a new product. There is a 95% learning curve effect.

Calculate how long it will take to produce the 7th unit.

Answer

The time to produce the seventh unit is the difference between:

- the total time to produce the first 6 units, and
- the total time to produce the first 7 units.

(1) **Learning factor**

$$\frac{\text{Logarithm } 0.95}{\text{Logarithm } 2} = \frac{-0.02227639}{0.30103} = -0.074$$

(2) **Average time to produce the first 6 units**

$$y = 500 \times \frac{1}{6^{0.074}}$$

= 500 (0.8758239)

= 437.9 hours per unit

(3) **Average time to produce the first 7 units**

$$y = 500 \times \frac{1}{7^{0.074}}$$

= 500 (0.86589)

= 432.9 hours per unit

(4) **Time to produce the 7th unit**

	Hours
Total time for the first 7 units (7 × 432.9)	3,030.3
Total time for the first 6 units (6 × 437.9)	2,627.4
Time for the 7th unit	402.9

5.5 Conditions for the learning curve to apply

The learning curve effect will only apply in the following conditions:

- There must be stable conditions for the work, so that learning can take place. For example, labour turnover must not be high; otherwise the learning effect is lost. The time between making each subsequent unit must not be long; otherwise the learning effect is lost because employees will forget what they did before.
- The activity must be labour-intensive, so that learning will affect the time to complete the work.
- There must be no change in production techniques, which would require the learning process to start again from the beginning.
- Employees must be motivated to learn.

The costs that are reduced as a result of the learning curve are those that vary with labour time – labour costs and any overhead costs that vary with labour time. The learning effect will not usually result in reductions in materials costs, for example, because the usage of materials (ignoring losses through wastage) is not related to labour efficiency.

Problems with using the learning curve

In practice, the learning curve effect is not used extensively for budgeting or estimating costs (or calculating sales prices on a cost plus basis).

- In a modern manufacturing environment production is highly mechanised and therefore the learning curve effect does not apply.
- For many products where skilled labour is required, production might have reached a 'steady state' so that there will be no further reductions in the average times to produce the item.
- Even with skilled, labour-intensive work, if there is a high rate of labour turnover, the work force might not gain enough collective experience for a learning effect to apply.

Other aspects of quantitative analysis in budgeting

- Expected values (EVs) in budgeting
- Spreadsheets in budgeting
- Spreadsheets and 'what if' analysis
- Dangers with using spreadsheets for budgeting

6 Other aspects of quantitative analysis in budgeting

6.1 Expected values (EVs) in budgeting

Just as expected values might be used in accounting for short-term decisions, they might also be used in budgeting. An expected value is a weighted average value of probable outcomes, where the likelihood of each different possible outcome can be estimated as a probability.

Expected values can be a reliable basis for making estimates, where an outcome will occur many times, and the EV becomes an estimate of the average. For example, expected values might be used to estimate the average number of rejected items from a process, or the average loss from a process.

Expected values are much less reliable as estimates for events or outcomes that will happen only once (or a limited number of times) during the budget period. For example, a budget estimate of sales volume for the period might be a 20% probability of sales of $5,000,000, a 50% probability of $6,000,000 and a 30% probability of $9,000,000. The expected value of sales would be $6,700,000 (0.20 × $5m + 0.50 × $6m + 0.30 × $9m).

However, this volume of sales is not one of the probable outcomes and is therefore not expected to occur. Preparing a budget on the basis of expected sales of $6,700,000 would therefore be inappropriate. It would possibly make more sense to prepare a budget on the basis of the most likely sales ($6 million), and possible also to prepare flexible budgets for sales of $5 million and $9 million).

The problems of using EVs for budgeting are therefore the same as the problems with using EVs for short-term decision-making, as explained in an earlier chapter.

6.2 Spreadsheets in budgeting

Spreadsheets are used extensively in budgeting, because long and detailed calculations can be made very quickly, and the same basic model can be used from one year to the next. Examples of applications of spreadsheets in management accounting include:

- Preparing forecasts of sales, and forecasts of profit or loss
- Cost estimation using linear regression analysis and the calculation of a correlation coefficient and coefficient of determination

- Preparing financial plans, such as budgets
- Comparing actual results with a plan or budget (control reporting).

Example

Here is a very simple example of a simple accounting calculation entered as text, numbers and formulae in a spreadsheet.

Column	C	D	E	F
Row				
		1st 6 months	**2nd 6 months**	**Year**
4	Output (units)	10,000	15,000	= D4+E4
5		$	$	$
6	Variable costs	=D4*F11	=E*F11	=D6+E6
7	Fixed costs	40,000	=D7	=D7+E7
8	Total costs	=D6+D7	=E6+E7	=D8+E8
9				
10	Average cost/unit	=D8/D4	=E8/E4	=F8/F4
11	Variable cost/unit			3.00

This would appear on screen as follows:

Column	C	D	E	F
Row				
		1st 6 months	**2nd 6 months**	**Year**
4	Output (units)	10,000	15,000	25,000
5		$	$	$
6	Variable costs	30,000	45,000	75,000
7	Fixed costs	40,000	40,000	80,000
8	Total costs	70,000	85,000	155,000
9				
10	Average cost/unit	7.00	5.67	6.20
11	Variable cost/unit			3.00

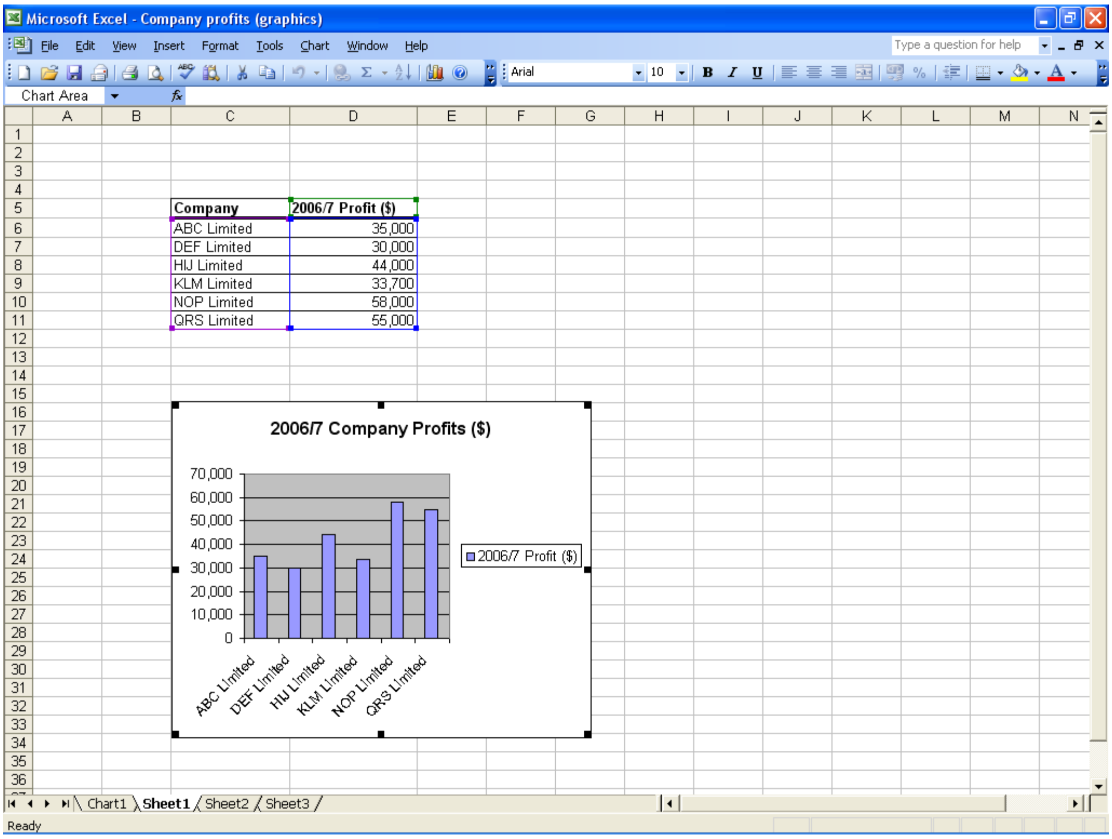
The figures can be re-calculated using different figures for output in each half of the year, or different figures for fixed costs or the unit variable costs. All that is required is an alteration to the number in cells D4, E4, D7 or F11.

Graphical reproduction of spreadsheet data

The figures in a spreadsheet can be converted by the spreadsheet program into graphical display format, and shown as graphs, bar charts or pie charts. This facility can also be very useful for the preparation of management reports.

For example, if a spreadsheet is used for linear regression analysis, it can be used to show the line of best fit as a graph. Similarly, if a spreadsheet is used to prepare an estimate of costs, the percentage of total costs made up by different items of cost (direct materials, direct labour, production overheads etc) can be shown as a pie chart or a bar chart.

The example below shows how the profits for six different companies can be shown in the form of a graph using the 'Chart Wizard' facility in Microsoft Excel



6.3 Spreadsheets and 'what if' analysis

A useful feature of spreadsheets is the ability to carry out sensitivity analysis easily and quickly. Each analysis of the sensitivity of the outcome to changes in a key variable can be made quickly, by amending one or two items in the spreadsheet. A task that could take hours if done by hand can be finished in a few minutes, or even seconds, using a spreadsheet.

If a spreadsheet is used to prepare a budget, by changing some key assumptions and seeing what happens to the profit, sensitivity analysis would provide management with information about the sensitivity of the budget to changes in different assumptions about unit costs, sales volumes or selling prices.
For example a budget in a spreadsheet model can be re-calculated changing the assumption about sales volume from, say, '50,000 units in month 1 and rising by 1,000 units each month' to '48,000 units in month 1 and rising by 800 units in each month'. This would need amendments to just two cells in the spreadsheet.

6.4 Dangers with using spreadsheets for budgeting

Although spreadsheets are used extensively for budgeting, there are some common problems ('dangers') with using them.

- It can be easy to forget the assumptions on which a spreadsheet model is based. A spreadsheet model might even be so large and complex that its users do not know or do not understand the assumptions on which the model is based. It is dangerous to use models without knowing 'how the model works'.
- Because it is so easy to make changes to a spreadsheet model for a budget and produce a new version of a budget, there is a danger that a large number of different versions of a budget might be produced, and managers might get confused about which is the 'official' version.

CHAPTER

9

Standard costing

Contents

Using and deriving standard costs

- Standard units of product or service
- Standard cost defined
- Standard costing
- The uses of standard costing
- Deriving a standard cost
- Types of standard
- Reviewing standards

1 Using and deriving standard costs

1.1 Standard units of product or service

A standard costing system may be used when an entity produces standard units of product or service that are identical to all other similar units produced. Standard costing is usually associated with standard products, but can be applied to standard services too.

A standard unit should have exactly the same input resources (direct materials, direct labour time) as all other similar units, and these resources should cost exactly the same. Standard units should therefore have the same cost.

1.2 Standard cost defined

A **standard cost is a predetermined unit cost** based on expected direct materials quantities and expected direct labour time, and priced at a predetermined rate per unit of direct materials and rate per direct labour hour and rate per hour of overhead.

- Standard costs of products are usually restricted to production costs only, not administration and selling and distribution overheads.
- Overheads are normally absorbed into standard production cost at an absorption rate per direct labour hour.

Example

The standard cost of a Product XYZ might be:

	£	£
Direct materials:		
Material A: 2 litres at $4.50 per litre	9.00	
Material B: 3 kilos at $4 per kilo	12.00	
		18.00
Direct labour		

Grade 1 labour: 0.5 hours at $20 per hour	10.00	
Grade 2 labour: 0.75 hours at $16 per hour	12.00	
		22.00
Variable production overheads: 1.25 hours at $4 per hour		5.00
Fixed production overheads: 1.25 hours at $40 per hour		50.00
Standard (production) cost per unit		95.00

Who sets standard costs?

Standard costs are set by managers with the expertise to assess what the standard prices and rates should be. Standard costs are normally reviewed regularly, typically once a year as part of the annual budgeting process.

- Standard prices for direct materials should be set by managers with expertise in the purchase costs of materials. This is likely to be a senior manager in the purchasing department (buying department).
- Standard rates for direct labour should be set by managers with expertise in labour rates. This is likely to be a senior manager in the human resources department (personnel department).
- Standard usage rates for direct materials and standard efficiency rates for direct labour should be set by managers with expertise in operational activities. This may be a senior manager in the production or operations department, or a manager in the technical department.
- Standard overhead rates should be identified by a senior management accountant, from budgeted overhead costs and budgeted activity levels that have been agreed in the annual budgeting process.

1.3 Standard costing

Standard costing is a system of costing in which:

- all units of product (or service) are recorded in the cost accounts at their standard cost, and
- the value of inventory is based on standard production cost.

Differences between actual costs and standard costs are recorded as variances, and variances are reported at regular intervals (typically each month) for the purpose of budgetary control.

Standard costing may be used with either a system of absorption costing or a system of marginal costing. The only difference is in the valuation of inventory and the calculation of variances for fixed overheads.

1.4 The uses of standard costing

Standard costing has four main uses.

- It is an alternative system of cost accounting. In a standard costing system, all units produced are recorded at their standard cost of production.
- When standard costs are established for products, they can be used to prepare the budget.
- It is a system of **performance measurement**. The differences between standard costs (expected costs) and actual costs can be measured as variances. Variances can be reported regularly to management, in order to identify areas of good performance or poor performance.
- It is also a system of **control reporting**. When differences between actual results and expected results (the budget and standard costs) are large, this could indicate that operational performance is not as it should be, and that the causes of the variance should be investigated. Management can therefore use variance reports to identify whether control measures might be needed, to improve poor performance or continue with good performances.

When there are large adverse variances, this might indicate that actual performance is poor, and control action is needed to deal with the weaknesses.

When there are large favourable variances, and actual results are much better than expected, management should investigate to find out why this has happened, and whether any action is needed to ensure that the favourable results continue in the future.

Variances and controllability

The principle of controllability should be applied in any performance management system

When variances are used to measure the performance of an aspect of operations, or the performance of a manager, they should be reported to the manager who is:

- responsible for the area of operations to which the variances relate, and
- able to do something to control them.

There is no value or practical purpose in reporting variances to a manager who is unable to do anything to control performance by sorting out problems that the variances reveal and preventing the variances from happening again.

It is also unreasonable to make a manager accountable for performance that is outside his control, and for variances that he can do nothing about.

1.5 Deriving a standard cost

A standard variable cost of a product is established by building up the standard materials, labour and production overhead costs for each standard unit.

In a standard absorption costing system, the standard fixed overhead cost is a standard cost per unit, based on budgeted data about fixed costs and the budgeted production volume.

Example

A company manufactures two products, X and Y. In Year 1 it budgets to make 2,000 units of Product X and 1,000 units of Product Y. Budgeted resources per unit and costs are as follows:

	Product X	Product Y
Direct materials per unit:		
Material A	2 units of material	1.5 units of material
Material B	1 unit of material	3 units of material
Direct labour hours per unit	0.75 hours	1 hour

Costs	
Direct material A	\$4 per unit
Direct material B	\$3 per unit
Direct labour	\$20 per hour
Variable production overhead	\$4 per direct labour hour

Fixed production overheads per unit are calculated by applying a direct labour hour absorption rate to the standard labour hours per unit, using the budgeted fixed production overhead costs of \$120,000 for the year.

Required

Calculate the standard full production cost per unit of:

(a) Product X, and

(b) Product Y

Answer

First calculate the budgeted overhead absorption rate.

Budgeted direct labour hours	hours
Product X: (2,000 units × 0.75 hours)	1,500
Product Y (1,000 units × 1 hour)	1,000
	2,500

Budgeted fixed production overheads	\$120,000
Fixed overhead absorption rate/hour	\$48

	Product X		Product Y	
		$		$
Direct materials				
Material A	(2 units × $4)	8	(1.5 units × $4)	6
Material B	(1 unit × $3)	3	(3 units × $3)	9
Direct labour	(0.75 hours × $20)	15	(1 hour × $20)	20
Variable production overhead	(0.75 hours × $4)	3	(1 hour × $4)	4
Standard variable prod'n cost		29		39
Fixed production overhead	(0.75 hours × $48)	36	(1 hour × $48)	48
Standard full production cost		65		87

Deriving the standard usage for materials

The standard usage for direct materials can be obtained by using:

- historical records for material usage in the past, or
- the design specification for the product.

Deriving the standard efficiency rate for labour

The standard efficiency rate for direct labour can be obtained by using:

- historical records for labour time spent on the product in the past, or
- making comparisons with similar work and the time required to do this work, or
- 'time and motion study' to estimate how long the work ought to take.

Deriving the standard price for materials

The standard price for direct materials can be estimated by using:

- historical records for material purchases in the past, and
- allowing for estimated changes in the future, such as price inflation and any expected change in the trade discounts available.

Deriving the standard rate of pay for labour

Not all employees are paid the same rate of pay, and there may be differences to allow for the experience of the employee and the number of years in the job. There is also the problem that employees may receive an annual increase in pay each year to allow for inflation, and the pay increase may occur during the middle of the financial year.

- The standard rate of pay per direct labour hour will be an average rate of pay for each category or grade of employees.
- The rate of pay may be based on current pay levels or on an expected average pay level for the year, allowing for the expected inflationary pay rise during the year.

1.6 Types of standard

Standards are predetermined estimates of unit costs but how is the level of efficiency inherent in the estimate determined? Should it assume perfect operating conditions or should it incorporate an allowance for waste and idle time? The standard set will be a performance target and if it seen as unattainable this may have a detrimental impact on staff motivation. If the standard set is too easy to attain there may be no incentive to find improvements.

There are four types of standard, and any of these may be used in a standard costing system:

- **Ideal standards**. These assume perfect operating conditions. No allowance is made for wastage, labour inefficiency or machine breakdowns. The ideal standard cost is the cost that would be achievable if operating conditions and operating performance were perfect. In practice, the ideal standard is not achieved.
- **Attainable standards**. These assume efficient but not perfect operating conditions. An allowance is made for waste and inefficiency. However the attainable standard is set at a higher level of efficiency than the current performance standard, and some improvements will therefore be necessary in order to achieve the standard level of performance.
- **Current standards**. These are based on current working conditions and what the entity is capable of achieving at the moment. Current standards do not provide any incentive to make significant improvements in performance, and might be considered unsatisfactory when current operating performance is considered inefficient.
- **Basic standards**. These are standards which remain unchanged over a long period of time. Variances are calculated by comparing actual results with the basic standard, and if there is a gradual improvement in performance over time, this will be apparent in an improving trend in reported variances.

When there is waste in production, or when idle time occurs regularly, current standard costs may include an allowance for the expected wastage or expected idle time. This is considered in more detail later.

Types of standard: behavioural aspects

One of the purposes of standard costing is to set performance standards that motivate employees to improve performance. The type of standard used can have an effect on motivation and incentives.

- Ideal standards are unlikely to be achieved. They may be very useful as long term targets and may provide senior managers with an indication of the potential for savings in a process but generally the ideal standard will not be achieved. Consequently the reported variances will always be adverse. Employees may becoming de-motivated when their performance level is always worse than standard and they know that the standard is unachievable.
- Current standards may be useful for producing budgets as they are based on current levels of efficiency and may therefore give a realistic guide to resources required in the production process. However current standards are unlikely to motivate employees to improve their performance, unless there are incentives

for achieving favourable variances (for achieving results that are better than the standard), such as annual cash bonuses.

- Basic standards will not motivate employees to improve their performance as they are based on achievable conditions at some time in the past. They are also not useful for budgeting because they will often be out of date. In practice, they are the least common type of standard.
- Attainable standards are the most likely to motivate employees to improve performance as they are based on challenging but attainable targets. It is for this reason that standards are often based on attainable conditions. However, a problem with attainable standards is deciding on the level of performance that should be the target for achievement. For example, if an attainable standard provides for some improvement in labour efficiency, should the standard provide for a 1% improvement in efficiency, or a 5% improvement, or a 10% improvement?

1.7 Reviewing standards

How often should standards be revised? There are several reasons why standards should be revised regularly.

- Regular revision leads to standards which are meaningful targets that employees may be motivated to achieve (for example, through incentive schemes).
- Variance analysis is more meaningful because reported variances should be realistic.
- In practice, standards are normally reviewed annually. Standards by their nature are long-term averages and therefore some variation is expected over time. The budgeting process can therefore be used to review the standard costs in use.

Allowing for waste and idle time

- Materials and waste
- Materials wastage in standard costing
- Idle time and standard costing

2 Allowing for waste and idle time

2.1 Materials and waste

Waste is an unavoidable feature of some production processes. The actual amount of materials wasted may vary from one period to another, but there may be a standard rate of wastage or a 'normal' rate of loss which is a measure of the average rate of wastage or loss.

Process costing, normal loss and abnormal loss

In process costing systems, an allowance is made for 'normal loss', which is the average expected rate of loss or wastage in the process. Normal loss is not given any cost, and the costs of actual production are based on expected output after allowing for the normal loss. If actual loss differs from normal loss, the difference is reported as abnormal loss (which is given a cost) or abnormal gain (which is given a value).

You may be familiar with process costing from your earlier studies, but a simple example will be used to explain how the concept of normal loss is used.

Example

A company manufactures a product in a process production system. There is some wastage in production, and normal loss is 10% of the number of units input to the process.

During December, 10,000 kilos were input to the process and total costs of production were $81,000. Actual output from the process was 8,600 kilos.

What was the cost of finished output in the month and what was the cost of the abnormal loss?

Answer

Input was 10,000 kilos. Normal loss (expected loss) is 10% of input; therefore the expected output is 9,000 kilos.

The cost per unit produced is calculated as:

$$\frac{\text{Costs of production}}{\text{Expected units of output}}$$

In this example, this is $81,000/9,000 kilos = $9 per kilo.

Abnormal loss is the amount by which actual loss (1,400 kilos) exceeds normal loss (1,000 kilos). Abnormal loss is therefore 400 kilos, and abnormal loss is given a cost. The cost per unit of abnormal loss is the same as the cost per unit of finished output. Abnormal loss is written off as an expense to profit or loss.

In this example:

- The cost of finished output = 8,600 kilos × $9 per kilo = $77,400.
- Cost of abnormal loss = 400 kilos × $9 per kilo = $3,600 (written off as an expense to profit or loss).

Abnormal gain

Abnormal gain occurs when actual loss is less than the normal loss. Abnormal loss is given a value, in the same way that abnormal loss is given a cost. Whereas abnormal loss is written off to profit or loss as an expense, abnormal gain is treated as an adjustment that adds to profit in the period.

In the previous example, if actual output had been 9,200 kilos (rather than 8,600 kilos):

- There cost per unit of finished output would be the same as before, $9 per kilo.
- There would be abnormal gain = 9,200 – 9,000 kilos = 200 kilos.
- The cost of finished output = 9,200 kilos × $9 per kilo = $828500
- Value of abnormal gain = 200 kilos × $9 per kilo = $1,800 (taken to profit or loss, as an adjustment that increases profit for the period).

2.2 Materials wastage in standard costing

An allowance for expected loss may also be included in a standard cost, in a similar way. The standard cost can be based on the expected quantity of input materials required to produce one unit of output.

Example

A company manufactures a product in a process production system. There is some wastage in production, and normal loss is 10% of the number of units input to the process.

The standard price per unit of direct material is $4.50 per unit.

What would be the standard direct material cost per unit of output:

(a) if an ideal standard is used, and the standard does not provide for any loss in process?

(b) if the standard cost allows for a loss of 10% of input materials in producing each unit of output.

Answer

(a) **Ideal standard**

No loss; therefore standard cost =
1 unit of direct materials at \$4.50 per unit of material = \$4.50 per unit of output.

(b) **Attainable or current standard: allow for 10% loss**
Standard input to produce one unit of = 1/0.9 units = 1.111 units.
Therefore standard cost =
1.111 units of materials at \$4.50 per unit = \$5 per unit of output.

Example

A company produces sandwiches. Each sandwich requires two slices of bread and a loaf of bread contains 24 slices. Each loaf of bread costs \$6. It is estimated that currently 20% of bread is wasted. Management would like to reduce this wastage to 10%.

Calculate a standard material cost for a sandwich based on

a) Ideal conditions
b) Current conditions
c) Attainable conditions

Answer

Standard cost per slice of bread = \$6/24 slices = \$0.25

(a) Ideal standard: 2 slices × \$0.25 = \$0.50
(b) Current standard: 2/0.80 slices = 2.5 slices at \$0.25 = \$0.625
(c) Attainable or target standard: 2/0.9 = 2.22 slices at \$0.25 = \$0.555.

Note that the current and attainable standard costs include an allowance for wastage, and a materials usage variance will occur only if the actual wastage rate differs from the standard wastage rate.

2.3 Idle time and standard costs

Idle time occur when the direct labour employees are being paid but have no work to do. The causes of idle time may be:

- A breakdown in production, for example a machine breakdown that halts the production process

- Time spent waiting for work due to a bottleneck or hold-up at an earlier stage in the production process
- Running out of a vital direct material, and having to wait for a new delivery of the materials from a supplier.
- A lack of work to do due to a lack of customer orders.

A feature of idle time is that it is recorded, and the hours 'lost' due to idle time are measured.

Sometimes idle time may be an unavoidable feature of the production process, so that an allowance for idle time is included in the standard cost.

Methods of including idle time in standard costs

There are at least three ways of allowing for idle time in a standard cost.

- **Method 1**. Include idle time as a separate element of the standard cost, so that the standard cost of idle time is a part of the total standard cost per unit.
- **Method 2**. Allow for a standard amount of idle time in the standard hours per unit for each product. This is the same approach described above for materials wastage and standard costing. The standard hours per unit therefore include an allowance for expected idle time.
- **Method 3**. Allow for the expected idle time by adjusting the standard rate per hour. This approach has been used in the suggested solutions to an F5 examination question in the past. However, we strongly advise against it, because idle time is about efficiency and labour time, not the rate per hour paid to employees. Even so, the technique is illustrated below.

Example

A company manufactures Product X. Due to the nature of the production process, there is some idle time and it has been estimated that the 'normal' amount of idle time is 10% of hours worked.

Ignoring idle time, the standard time to make 1 unit of Product X is 0.36 hours. Labour is paid $18 per hour.

This means that the labour time to make 1 unit of product X is 0.36/0.90 = 0.40 hours, of which 0.04 hours are idle time.

There are three ways of making an allowance for in the standard cost the expected idle time.

Method 1: Include idle time as a separate element of the standard cost. The standard cost per unit will include the following items:

	$
Active hours worked: 0.36 hours × $18 per hour	6.48
Idle time: 0.04 hours × $18 per hour	0.72
	7.20

Method 2
Include an allowance for expected idle time in the standard efficiency rate:
Standard cost = 0.40 hours × $18 per hour = $7.20

Method 3 (not recommended)
Adjust the rate of pay per hour to allow for the expected idle time.
The rate per hour should be adjusted to $18/0.90 = $20 per hour.
Standard cost = 0.36 hours × $20 = $7.20.

Method 3 is not recommended because:

- The calculation of variances is more complex than with methods 1 and 2, and
- It is unrealistic to adjust the rate of pay per hour: the rate of pay per hour and idle time are unrelated issues.

The next section of this chapter will demonstrate the calculation of variances when wastage of materials or idle time is provided for in the standard cost.

CHAPTER 10

Basic variance analysis

Contents

Standard costs and cost variances

- Standard costing and budgetary control
- Cost variances: favourable and adverse variances
- Variances and performance reporting
- The total cost variance for a variable cost item

1 Standard costs and cost variances

1.1 Standard costing and budgetary control

In a previous chapter, it was explained that flexed budgets can be used to compare actual results with expected (budgeted results), and differences between actual results and the budget can be explained as the sum of several variances:

- A sales price variance
- A direct materials cost variance
- A direct labour cost variance
- A variable production overheads cost variance
- A fixed overhead variance, which can be analysed into an expenditure variance and a volume variance
- An expenditure variance for 'other costs' (administration and sales)
- A sales volume variance.

Standard costs can be used to provide similar variance information to variances using a flexed budget, with the difference that the reasons for cost variances are analysed into more detail.

You may be familiar with the calculation of basic variances from your previous studies. If you are not familiar with basic variances, their calculation and possible causes are explained in this chapter.

1.2 Cost variances: favourable and adverse variances

In a standard costing system, all units of output are valued at their standard cost. The cost of production and the production cost of sales are therefore valued at standard cost.

Actual costs will differ from standard costs. A cost variance is the difference between an actual cost and a standard cost.

- When actual cost is higher than standard cost, the cost variance is adverse [(A)] variance or unfavourable [(U)].
- When actual cost is less than standard cost, the cost variance is favourable [(F)].

Several different variances are calculated, relating to direct materials, direct labour, variable production overhead and fixed production overhead. There are also some sales variances.

In a cost accounting system, cost variances are adjustments to the profit in an accounting period.

- Favourable variances adjust the profit upwards.
- Adverse variances adjust the profit down.

Variance reports are produced at the end of each control period (say, at the end of each month).

- Large adverse variances indicate poor performance and the need for control action by management.
- Large favourable variances indicate unexpected good performance. Management might wish to consider how this good performance can be maintained in the future.

The method of calculating cost variances is similar for all variable production cost items (direct materials, direct labour, variable production overhead).

A different method of calculating cost variances is required for fixed production overhead.

1.3 The total cost variance for a variable cost item

The total cost variance for the variable cost item is the difference between the actual variable cost of production and the standard variable cost of producing the items. However, the total cost variance is not usually calculated. Instead, the total cost variance is normally analysed into two causes:

- **Price variance/rate variance/expenditure per hour variance**. This compares the actual cost of the material resources used or the actual hours worked with the standard price of the materials or the standard rate per hour.
- **Usage/efficiency variance**. This measures the difference in cost between the actual materials used and the standard usage quantity, or the actual hours worked and the standard hours for the work.

Total variable cost variance

X units actually produced:		
	$	
X units of output should cost (× Standard cost per unit)	A	
X units of output did cost	B	
Total cost variance for the variable cost item	A – B	(F) or (A)

Example

A unit of Product P123 has a standard cost of five litres of Material A at $3 per litre. The standard direct material cost per unit of Product 123 is therefore $15.

In a particular month, 2,000 units of Product 123 were manufactured. These used 10,400 litres of Material A, which cost $33,600.

The total direct material cost variance is calculated as follows:

	$	
2,000 units of output (product P123) should cost (× $15)	30,000	
They did cost	33,600	
Total direct materials cost variance	3,600	(A)

The total direct materials cost variance is adverse, because actual costs were higher than the standard cost.

Direct materials: price and usage variances

- Direct materials price variance
- Direct materials usage variance
- Causes of materials price and usage variances

2 Direct materials: price and usage variances

The direct materials total cost variance can be analysed into a price variance and a usage variance.

2.1 Direct materials price variance

A materials price variance is the difference between:

- the actual cost of the materials purchased (or used) and
- what they should have cost (the actual materials purchased or used at their standard price).

The calculation of a materials price variance can be set out in a table, as follows:

Materials price variance	**$**	
Units of materials purchased should cost (actual materials purchased × standard price per unit)	X	
They did cost	Y	
Material price variance	X - Y	(F) or (A)

The variance is:

- favourable if the actual cost was less than the expected cost of the materials, and
- adverse if the actual cost was more than the expected cost.

Example

A unit of Product P123 has a standard cost of five litres of Material A at $3 per litre. The standard direct material cost per unit of Product 123 is therefore $15. In a particular month, 2,000 units of Product 123 were manufactured. These used 10,400 litres of Material A, which cost $33,600.

The total direct material cost variance is $3,600 (A), as calculated earlier, in the previous example.

The materials price variance is calculated as follows:

	$	
10,400 litres of materials should cost (× $3)	31,200	
They did cost	33,600	
Material price variance	2,400	(A)

The price variance is adverse because the materials cost more to purchase than they should have.

2.2 Direct materials usage variance

A materials usage variance is the difference between:

- the actual materials used and
- the amount of materials that should have been used for the quantity of units produced (the actual units of output produced × standard usage quantity per unit).

This variance is converted into a money value at the standard price per unit of materials.

The calculation of a materials usage variance can be set out in a table, as follows:

Materials usage variance	**Units of material**	
Units produced should use (× standard material usage per unit)	X	
They did use	Y	
Material usage variance in quantities	X – Y	(F) or (A)
× Standard price per unit of material	$P	
Material price variance in $	(X – Y) × $P	(F) or (A)

Example

Using the same example above that was used to illustrate the material price variance, the usage variance should be calculated as follows:

	kilos	
2,000 units of Product P123 should use (× 5 kilos)	10,000	
They did use	10,400	
Material usage variance in kilos	400	(A)
Standard price per kilo of Material A	$3	
Material usage variance in $	$1,200	(A)

The usage variance is adverse because more materials were used than expected, and this has added to costs.

2.3 Causes of materials price and usage variances

Some of the possible causes of materials variances are set out in the table below. Note that there may be some inter-relationship between a usage variance and a price variance: for example buying and using low-quality materials might provide a favourable price variance, but due the lower quality there may be more wastage and so an adverse materials usage variance

Possible causes

Materials usage variance	**Materials price variance**
Inefficient use of materials: wastage rates higher than expected.	Actual purchase prices higher or lower than standard
Efficient use of materials: wastage rates lower than expected	Price inflation higher or lower than expected (and allowed for in the standard price)
Inexperienced work force; therefore greater wastage of materials	Buying in larger quantities than normal, so that the entity benefits from better trade discounts.
Poor quality of materials than 'standard', resulting in higher quantity of loss or waste	Buying smaller quantities than normal, so that the entity loses trade discounts from suppliers.
Better quality of materials than 'standard', resulting on lower loss or wastage.	A new supplier has been identified who sells the materials at a lower price.
Improvements in production methods, resulting in more efficient use of materials.	Some materials had to be purchased in an emergency and at short notice, so that the price paid (for a fast delivery service) was much higher than normal.
Better quality control in the production process (favourable usage variance)	Inefficient buying. Buying without asking two or more suppliers to quote a price.
Also: The standard usage rate in the standard cost for materials might be a poor estimate	**Also**: The standard materials price in the standard cost for materials might be a poor estimate

Direct labour: rate and efficiency variances

- Total direct labour cost variance
- Direct labour rate variance
- Direct labour efficiency variance
- Causes of labour rate and efficiency variances

3 Direct labour: rate and efficiency variances

3.1 Total direct labour cost variance

The total cost variance for direct labour is the difference between the standard and actual direct labour cost for the units produced.

e

Example

Product P123 has a standard direct labour cost per unit of:

1.5 hours × $12 per direct labour hour = $18 per unit.

During a particular month, 2,000 units of Product 123 were manufactured. These took 2,780 hours to make and the direct labour cost was $35,700.

Required

Calculate the total direct labour cost variance.

a

Answer

	$	
2,000 units of output should cost (× $18)	36,000	
They did cost	35,700	
Total direct labour cost variance	300	(F)

The variance is favourable, because actual costs were less than the standard cost.

The direct labour total cost variance can be analysed into a rate variance and an efficiency variance. The calculations are similar to the calculations for the materials price and usage variances.

3.2 Direct labour rate variance

A direct labour rate variance is the difference between:

- the actual cost of the direct labour (hours paid for) and
- what the hours should have cost (the actual hours paid for at their standard rate).

The calculation of a direct labour rate variance can be set out in a table, as follows:

Direct labour rate variance	$	
The hours worked should cost (actual hours worked × standard rate per hour)	X	
They did cost	Y	
Direct labour rate variance	X - Y	(F) or (A)

The variance is:

- favourable if the actual cost was less than the expected cost of the hours worked, and
- adverse if the actual cost was more than the expected cost.

Example

Using the same example that was used previously to calculate the total labour cost variance, calculate the direct labour rate variance.

Answer

	$	
2,780 hours should cost (× $12)	33,360	
They did cost	35,700	
Direct labour rate variance	2,340	(A)

The rate variance is adverse because the labour hours worked cost more than they should have.

3.3 Direct labour efficiency variance

A direct labour efficiency variance is the difference between:

- the actual hours worked and
- the hours that should have been required to make the quantity of units produced (the actual units of output produced × standard hours per unit).

This variance is converted into a money value at the standard labour rate per hour.

The calculation of a labour efficiency variance can be set out in a table, as follows:

Direct labour efficiency variance	**hours**	
Actual units produced should take (× standard hours per unit)	X	
They did take	Y	
Direct labour efficiency variance in hours	X – Y	(F) or (A)
× Standard rate per hour	\$R	
Direct labour efficiency variance in \$	(X – Y) × \$R (F) or (A)	

Example

Using the same example above that was used to illustrate the total direct labour cost variance and the direct labour rate variance, the efficiency variance should be calculated as follows:

	hours	
2,000 units of Product P123 should take (× 1.5 hours)	3,000	
They did take	2,780	
Efficiency variance in hours	220	(F)
Standard direct labour rate per hour	\$12	
Direct labour efficiency variance in \$	\$2,640	(F)

The efficiency variance is favourable because production took less time than expected, which has reduced costs.

Labour cost variances: summary	\$	
Labour rate variance	2,340	(A)
Labour efficiency variance	2,640	(F)
Total direct labour cost variance	300	(F)

3.4 Causes of labour rate and efficiency variances

Some of the possible causes of labour variances are set out in the table below. As with materials, note that there may be some inter-relationship between a labour rate variance and an efficiency variance: for example using employees with relatively little experience of the work may result in a favourable rate variance, but also an adverse efficiency variance.

Possible causes

Labour efficiency variance	Labour rate variance
Efficient or inefficient working by the work force. Efficiency variance will always be adverse when an ideal standard is used and will often be adverse when an attainable/target standard is used.	The grade or level of labour actually used was different from the grade of labour in the standard cost
Due to high labour turnover, the work force was relatively new and inexperienced, resulting in lower efficiency	Due to high labour turnover, the work force was relatively new and inexperienced, and paid less than the standard rate of pay
Quality of supervision good or bad, resulting in favourable or unfavourable efficiency variance	Wage rates have been altered (usually, raised).
The effect of a new incentive scheme, which has been an improvement in efficiency	
Problems in the production process, for example machine breakdowns, reducing efficiency	

Variable production overheads: expenditure and efficiency variances

- Total variable production overhead cost variance
- Variable production overhead expenditure variance
- Variable production overhead efficiency variance
- Causes of variable overhead variances

4 Variable production overheads: expenditure and efficiency variances

4.1 Total variable production overhead cost variance

The total cost variance for variable production overhead is the difference between the standard and actual variable production overhead cost for the units produced.

e

Example

Product P123 has a standard variable production overhead cost per unit of:

1.5 hours × $2 per direct labour hour = $3 per unit. During a particular month, 2,000 units of Product 123 were manufactured. These took 2,780 hours to make and the variable production overhead cost was $6,550.

Required

Calculate for the month the total variable production overhead cost variance.

(Note: This same example will be used to illustrate the variable overhead expenditure and efficiency variances.)

a

Answer

	$	
2,000 units of output should cost (× $3)	6,000	
They did cost	6,550	
Total variable production overhead cost variance	550	(A)

The variance is adverse, because actual costs were more than the standard cost.

4.2 Variable production overhead expenditure variance

Variable production overheads are assumed to vary with the direct labour hours worked.

A variable production overhead expenditure variance is the difference between:

- the actual variable production overhead cost of the hours worked, and

- what the hours worked should have cost (the actual hours paid for at their standard rate per hour of variable overhead expenditure).

The calculation of a variable production overhead expenditure variance can be set out in a table, as follows:

Variable production overhead expenditure variance	$	
The hours worked should cost (actual hours worked × standard expenditure per hour)	X	
They did cost	Y	
Variable production overhead expenditure variance	X – Y	(F) or (A)

The variance is:

- favourable if the actual cost was less than the expected cost of the hours worked, and
- adverse if the actual cost was more than the expected cost.

Example

Using the same example that was used previously to calculate the total variable production overhead cost variance, calculate the variable production overhead expenditure variance.

Answer

	$	
2,780 hours should cost (× $2)	5,560	
They did cost	6,550	
Variable production overhead expenditure variance	990	(A)

The expenditure variance is adverse because the expenditure on variable overhead in the hours worked was more than it should have been.

4.3 Variable production overhead efficiency variance

A variable production overhead efficiency variance is the difference between:

- the actual hours worked, and
- the hours that should have been required to make the quantity of units produced (the actual units of output produced × standard hours per unit).

This is the same variance in hours as the direct labour efficiency variance (excluding any hours of idle time variance, because it is assumed that variable overhead expenditure is not incurred during idle time). This variance in hours is converted into a money value at the standard expenditure rate per hour.

The calculation of a variable production overhead efficiency variance can be set out in a table, as follows:

Variable production overhead efficiency variance	**hours**	
Units produced should take (× standard hours per unit)	X	
They did take	Y	
Variable production overhead efficiency variance in hours	X-Y	(F) or (A)
× Standard expenditure rate per hour	$R	
Variable production overhead efficiency variance in $	(X-Y) × $R (F) or (A)	

Example

Using the same example that was used previously to calculate the total variable production overhead cost variance and the variable production overhead expenditure variance, calculate the variable production overhead efficiency variance.

Answer

	hours	
2,000 units of Product P123 should take (× 1.5 hours)	3,000	
They did take	2,780	
Efficiency variance in hours	220	(F)
Standard variable production overhead rate per hour	$2	
Variable production overhead efficiency variance in $	$440	(F)

The efficiency variance is favourable because production took less time than expected, which has reduced costs.

Variable production overhead variances cost variances: summary	$	
Variable production overhead expenditure variance	990	(A)
Variable production overhead efficiency variance	440	(F)
Total variable production overhead cost variance	550	(A)

4.4 Causes of variable overhead variances

It is difficult to identify the causes of variable overhead variances, because variable overhead costs arise in all 'overhead' areas of operations, and the variable overhead rate per hour is likely to be an estimate obtained from high-low analysis or linear regression analysis of overhead costs.

The causes of variable overhead efficiency variances are the same as the causes of labour efficiency variances, when variable overhead expenditure is assumed to vary with the number of direct labour hours worked.

The causes of variable overhead expenditure variances may be:

- efficient or inefficient spending on overhead items of cost
- inaccurate estimates of the variable overhead expenditure rate per hour.

Fixed production overhead cost variances: absorption costing

- The structure of fixed overhead variances
- Total fixed overhead cost variance
- Fixed overhead expenditure and volume variances
- Fixed overhead efficiency and capacity variances
- ABC based variances

5 Fixed production overhead cost variances: absorption costing

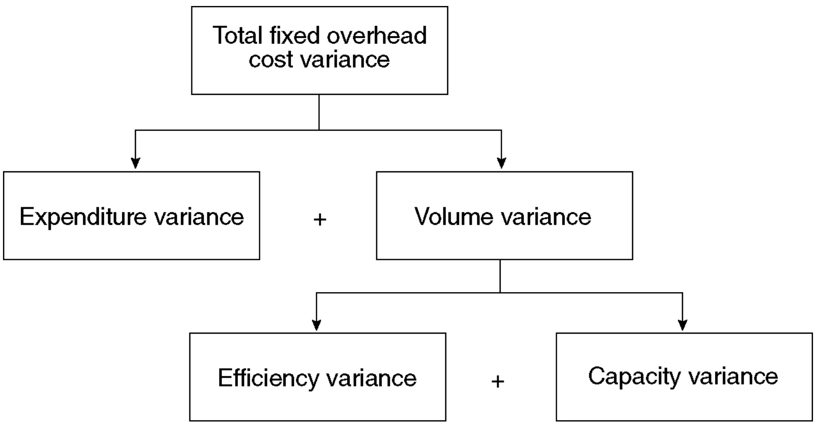
5.1 The structure of fixed overhead variances

With standard absorption costing, the standard cost per unit is a full production cost, including an amount for absorbed fixed production overhead. Every unit produced is valued at standard cost.

This means that production overheads are absorbed into production costs at a standard cost per unit produced.

However, this standard fixed cost per unit is derived from a standard number of direct labour hours per unit and a fixed overhead rate per hour.

Fixed overhead variances are as follows:



5.2 Total fixed overhead cost variance

The total fixed overhead cost variance is rarely calculated, because it is more usual to calculate the expenditure and volume variances.

However, the total fixed overhead cost variance is the amount of under-absorbed fixed production overhead (adverse variance) or over-absorbed fixed production overhead (favourable variance).

	$	
Standard fixed overhead cost of units produced	X	
(units produced × standard fixed cost per unit)		
Actual fixed overhead costs	Y	
Total fixed production overhead cost variance	X - Y	(F) or (A)
(= fixed overheads over- or under-absorbed)		

The variance is favourable when actual costs are less than standard costs, and there is over-absorption of overheads.

The variance is adverse when actual costs are higher than standard costs, and there is under-absorption of overheads.

5.3 Fixed overhead expenditure and volume variances

The total fixed overhead cost variance is usually analysed into an expenditure variance and a volume variance.

Fixed production overhead expenditure variance	**$**	
Budgeted fixed overheads	X	
Actual fixed overheads	Y	
Fixed production overhead expenditure variance	X – Y	(F) or (A)

Fixed overhead expenditure should be the same in total at any volume of output. If actual fixed overhead costs differ from expected fixed costs (budgeted fixed costs), the difference is an expenditure variance.

- The expenditure variance is favourable if actual fixed overhead costs are less than budgeted.
- The expenditure variance is adverse if actual fixed overhead costs are more than budgeted.

Fixed production overhead volume variance	**units**
Actual production volume	X
Budgeted production volume	Y
Fixed production overhead volume variance in units	X – Y
× Standard fixed overhead cost per unit	$C
Fixed production overhead volume variance in $	(X – Y) × $C (F) or (A)

Higher production volume results in greater overhead absorption so when actual volume exceeds budgeted volume the variance is favourable.

Example

A company budgeted to make 5,000 units of a single standard product in Year 1. Budgeted direct labour hours are 10,000 hours. Budgeted fixed production overhead is $40,000. Actual production in Year 1 was 5,200 units and fixed production overhead was $40,500.

Required

Calculate for Year 1:

- the fixed overhead total cost variance
- the fixed overhead expenditure variance
- the fixed overhead volume variance

Answer

Standard fixed overhead cost per unit = $8 (2 hours per unit × $4 per hour).

Fixed production overhead total cost variance	$	
5,200 units: standard fixed cost (× $8) = fixed overhead absorbed	41,600	
Actual fixed overhead cost expenditure	40,500	
Fixed production overhead total cost variance	1,100	(F)

The variance is favourable, because fixed overhead costs have been over-absorbed.

Fixed overhead expenditure variance	$	
Budgeted fixed production overhead expenditure	40,000	
Actual fixed production overhead expenditure	40,500	
Fixed overhead expenditure variance	500	(A)

This variance is adverse because actual expenditure exceeds the budgeted expenditure.

Fixed overhead volume variance	units of production	
Budgeted production volume in units	5,000	
Actual production volume in units	5,200	
Fixed overhead volume variance in units	200	(F)
Standard fixed production overhead cost per unit	$8	
Fixed overhead volume variance in $	$1,600	(F)

This variance is favourable because actual production volume exceeded the budgeted volume.

Summary	$	
Fixed overhead expenditure variance	500	(A)
Fixed overhead volume variance	1,600	(F)
Fixed overhead total cost variance	1,100	(F)

5.4 Fixed overhead efficiency and capacity variances

The fixed overhead volume variance can be analysed into an efficiency variance and a capacity variance. Together, efficiency and capacity variances explain why actual production volume in units was more or less than the budgeted production volume.

These variances are calculated as follows:

Fixed production overhead efficiency variance	hours	
Actual units produced should take (× standard hours per unit)	X	
They did take	Y	
Fixed production overhead efficiency variance in hours	X – Y	(F) or (A)
× Standard fixed overhead rate per hour	$R	
Fixed production overhead efficiency variance in $	(X – Y) × $R (F) or (A)	

Fixed production overhead capacity variance	hours	
Budgeted hours of work	X	
Actual hours of work	Y	
Capacity variance in hours	X – Y	(F) or (A)
× Standard fixed overhead rate per hour	$R	
Fixed overhead capacity variance in $	(X – Y) × $R (F) or (A)	

If actual hours are greater than budgeted, this is an increase in capacity. More products can be produced and this will increase profit. This is a favourable variance.

The **efficiency variance** is the same in hours as the efficiency variance for direct labour and variable production overheads. It is priced, however, at the fixed production overhead rate per hour.

The **capacity variance** is an hours worked variance. It is the difference between the budgeted hours and the actual hours worked, and it is priced at the fixed production overhead rate per hour.

Example

A company budgeted to make 5,000 units of a single standard product in Year 1. Budgeted direct labour hours are 10,000 hours. Budgeted fixed production overhead is $40,000. Actual production in Year 1 was 5,200 units in 10,250 hours of work, and fixed production overhead was $40,500.

Required

The fixed production overhead volume variance is $1,600(F), calculated earlier. Calculate for Year 1:

- the fixed overhead efficiency variance
- the fixed overhead capacity variance.

Answer

Fixed production overhead efficiency variance	**hours**	
5,200 units produced should take (× 2 hours per unit)	10,400	
They did take	10,250	
Fixed production overhead efficiency variance in hours	150	(F)
× Standard fixed overhead rate per hour	$4	
Fixed production overhead efficiency variance in $	$600	(F)

Fixed production overhead capacity variance	**hours**	
Budgeted hours of work	10,000	
Actual hours of work	10,250	
Capacity variance in hours	250	(F)
× Standard fixed overhead rate per hour	$4	
Fixed overhead capacity variance in $	$1,000	(F)

The capacity variance is favourable because actual hours worked exceeded the budgeted hours (therefore more units should have been produced).

Summary	$	
Fixed overhead efficiency variance	600	(F)
Fixed overhead capacity variance	1,000	(F)
Fixed overhead volume variance	1,600	(F)

Sales variances: sales price and sales volume variances

- Sales price variance
- Sales volume variance: units method
- Sales volume variance: standard selling price method
- Causes of sales price and sales volume variances

6 Sales variances: sales price and sales volume variances

Sales variances, unlike cost variances, are not recorded in a standard costing system of cost accounts. However, sales variances are included in variance reports to management.

- They help to reconcile actual profit with budgeted profit.
- They indicate to management to assess performance.

There are two sales variances:

- a sales price variance, and
- a sales volume variance.

These are calculated as shown below, when a standard absorption costing system is used.

6.1 Sales price variance

The sales price variance is the difference between:

- the actual sales revenue from the units sold, and
- the expected sales revenue from the units sold.

The sales price variance is calculated as follows:

	$	
Actual units sold should sell for (× standard sales price per unit)	X	
They did sell for (actual sales revenue)	Y	
Sales price variance	X – Y	(F) or (A)

The variance is favourable when actual sales revenue is higher than the value of sales at the standard selling price. The variance is adverse when actual sales were for less than the standard price.

6.2 Sales volume variance: units method

The sales volume variance, in standard absorption costing, explains:

- the difference between budgeted and actual profit
- that was caused by actual sales volume being different from the budgeted sales volume.

The sales volume variance can be calculated in units, as follows, and then converted into a monetary amount at the standard profit per unit.

Sales volume variance, absorption costing	Units of sales	
Budgeted sales volume (units)	X	
Actual sales volume (units)	Y	
Sales volume variance in units	X – Y	(F) or (A)
x Standard profit per unit	× $P	
Sales volume variance in $	(X – Y) × $P	(F) or (A)

6.3 Sales volume variance: standard selling price method

There is an alternative method of calculating the sales volume variance, which produces exactly the same figure for the variance. This is shown below.

Sales volume variance, absorption costing: alternative method of calculation	$	
Actual sales at standard selling price	X	
Budgeted sales	Y	
Sales volume variance in $ revenue	(X – Y)	(F) or (A)
Standard profit/sales price ratio	P%	
Sales volume variance (profit variance)	(X – Y) × P%	(F) or (A)

Example

A company budgets to sell 7,000 units of Product P456. The standard sales price of Product P456 is $50 per unit and the standard cost per unit is $42.

Actual sales were 7,200 units, which sold for $351,400.

The sales price variance and sales volume variance would be calculated as follows:

Sales price variance	$	
7,200 units should sell for (x $50)	360,000	
They did sell for	351,400	
Sales price variance	8,600	(A)

The sales price variance is adverse because actual sales revenue from the units sold was less than expected.

Sales volume variance: usual method of calculation	units	
Actual sales volume (units)	7,200	
Budgeted sales volume (units)	7,000	
Sales volume variance in units	200	(F)
Standard profit per unit ($50 – $42 = $8)	$8	
Sales volume variance (profit variance)	$1,600	(F)

The sales volume variance is favourable because actual sales exceeded budgeted sales.

Sales volume variance: alternative method of calculation	$	
Actual sales at standard selling price (5,200 × $50)	260,000	
Budgeted sales (5,000 units × $50)	250,000	
Sales volume variance in $ revenue	10,000	(F)
Standard profit/sales price ratio ($8/$50)	16%	
Sales volume variance (profit variance)	$1,600	(F)

Both methods of calculating the sales volume variance produce the same answer.

6.4 Causes of sales price and sales volume variances

Some of the possible causes of sales price and sales volume variances are set out in the table below.

Possible causes

Sales price variance	Sales volume variance
Strong demand for the product or service, so that higher sales prices could be charged.	Customers attracted by low price or deterred by high price for the product or service
Weak demand; therefore sales prices reduced to obtain sales.	Major new customer in the market, adding to total sales demand.
Trade discounts given to major customers for bulk orders.	Loss of major customer from the market, resulting in a fall in total market demand
Inflation, resulting in higher prices. General increase in prices in the market for the product or service.	Effective or ineffective advertising campaign.
New competitor in the market, so that prices were reduced as a competitive reaction.	Improvements in distribution methods, resulting in higher demand for the entity's products.

Improvements in the product deign or service delivery, resulting in higher demand for the entity's products.

Poor after-sales service resulting in loss of customers and fall in sales.

Reconciling budgeted and actual profit: standard absorption costing

- Purpose of an operating statement
- Format of an operating statement

7 Reconciling budgeted and actual profit: standard absorption costing

7.1 Purpose of an operating statement

A management report called an operating statement might be prepared, showing how the difference between the original budgeted profit and the actual profit is explained by the sales variances and cost variances.

The purpose of an operating statement is to enable management to assess actual performance, and identify aspects of performance where investigation or control action might be appropriate.

7.2 Format of an operating statement

In a standard absorption costing system, an operating statement can be set out as follows:

Operating statement (standard absorption costing)

			$	
Budgeted profit			BP	
Sales price variance			X	(F) or (A)
Sales volume variance			X	(F) or (A)
			X	
Cost variances	(F)	(A)		
	£	£		
Direct materials price	X			
Direct materials usage		X		
Direct labour rate		X		
Direct labour efficiency	X			
Variable production o'head expenditure	X			
Variable production o'head efficiency	X			
Fixed production overhead expenditure		X		
Fixed production overhead efficiency	X			
Fixed production overhead capacity		X		
Other overhead expenditure variances		X		
Total cost variances	Totals		X	(F) or (A)
Actual profit			AP	

Other overhead expenditure variances, assuming administration overheads and selling and distribution overheads are all fixed costs, are the difference between:

- budgeted other overheads expenditure, and
- actual other overheads expenditure.

Standard marginal costing

- Standard marginal costing and standard absorption costing compared
- Fixed production overhead variances in standard marginal costing
- Sales volume variance in standard marginal costing
- Standard marginal costing operating statement

8 Standard marginal costing

8.1 Standard marginal costing and standard absorption costing compared

When a company uses standard marginal costing rather than standard absorption costing:

- finished goods inventory is valued at the standard variable production cost, not the standard full production cost
- variances are calculated and presented in the same way as for standard absorption costing, but with two important differences:
  - fixed production overhead variances
  - sales volume variances.

8.2 Fixed production overhead variances in standard marginal costing

In standard marginal costing, there is a fixed production overhead expenditure variance, but no fixed production overhead volume variance.

The fixed production overhead expenditure variance is calculated in the way already described and is the same amount in a standard marginal costing system as in a standard absorption costing system.

8.3 Sales volume variance in standard marginal costing

In standard marginal costing, the sales volume variance is calculated using standard contribution, as follows:

Sales volume variance: usual method of calculation

	units	
Actual sales volume (units)	X	
Budgeted sales volume (units)	Y	
Sales volume variance in units	X - Y	(F) or (A)
Standard contribution per unit	\$C	
Sales volume variance (contribution variance)	$(X – Y) \times \$C$	(F) or (A)

Sales volume variance: alternative method of calculation

	$	
Actual sales at standard selling price	X	
Budgeted sales	Y	
Sales volume variance in $ revenue	(X – Y)	(F) or (A)
Standard contribution /sales ratio	C%	
Sales volume variance (contribution variance)	$(X – Y) x C%	(F) or (A)

Both methods of calculating the sales volume variance produce the same answer.

8.4 Standard marginal costing operating statement

An operating statement is presented in a different way. Budgeted contribution can be reconciled with actual contribution, by means of the sales price variance, sales volume variance and variable cost variances. Fixed cost expenditure variances should be presented in a separate part of the operating statement.

Operating statement: standard marginal costing

			$	
Budgeted profit			BP	
Add budgeted fixed costs			BF	
Budgeted contribution (BP + BF)			BC	
Sales price variance			X	(F) or (A)
Sales volume variance			X	(F) or (A)
Sales less standard variable cost of sales			X	
Variable cost variances	(F)	(A)		
	$	$		
Direct materials price	X			
Direct materials usage		X		
Direct labour rate		X		
Direct labour efficiency	X			
Variable production overhead rate	X			
Variable production o'head efficiency	X			
Total variable cost variances	Totals		X	(F) or (A)
Actual contribution			AC	
Budgeted fixed overhead expenditure	BF			
Fixed overhead expenditure variance	X	(F) or (A)		
Actual fixed production overheads			AF	
Actual profit (AC – AF)			AP	

Variances with waste and idle time

- Variances when waste is provided for in the standard cost
- Variances when idle time is provided for in the standard cost

9 Variances with waste and idle time

9.1 Variances when waste is provided for in the standard cost

When the standard cost provides for wastage or loss in production, it is usual to calculate the material usage variance by comparing the actual usage of materials with the expected usage of materials allowing for normal wastage. The calculation of the material usage variance should be straightforward, as the following example shows.

Example

A company makes a standard product. Each finished product contains 450 grams of raw material, but there is an expected loss in production equal to 5% or the materials input. Raw materials have a standard cost of $4 per kilogram.

During a period, 6,000 units of the product were manufactured and 3,240 kilograms of raw materials were input to production.

What was the direct materials usage variance for the period?

Answer

The standard cost of materials, allowing for normal wastage of 5% of input, is:
(450 grams × 100/95) at $4 per kilo
= 500 grams × $0.004 per gram = $2.
This can be re-stated as 0.5 kilos at $4 per kilo = $2.

	kilos	
6,000 units of product should use (× 0.5 kilos)	3,000	
They did use	3,240	
Material usage variance in kilos	240	(A)
Standard price per kilo	$4	
Material usage variance in $	$960	(A)

9.2 Variances when idle time is provided for in the standard cost

When the standard cost provides for idle time in production, the calculation of efficiency variances is more complicated. This is because within the total direct labour efficiency variance, there is:

- a separate idle time variance, which may be favourable or adverse: an idle time variance is favourable if actual idle time is less than expected
- an efficiency variance for hours worked excluding idle time.

Total direct labour efficiency variance = Idle time variance + Efficiency variance in other time

A second complication is that standard idle time (expected idle time) can be measured in two different ways:

- in terms of the output actually produced, or
- in terms of the hours actually worked.

Each of these two ways produces a different value for the idle time variance.

An example will be used to illustrate the two different methods of calculating the variances.

Example

A company makes a standard product. Each finished product should take 18 minutes of active labour time, but idle time is budgeted and included in the standard cost. Expected idle time is 10% of hours worked. The standard labour rate of pay is $15 per hour worked.

During a period, 3,600 units of the product were manufactured. 1,000 labour hours worked and of these, 70 were recorded as idle time.

What were the following variances in the period?

- Total direct labour efficiency variance
- Idle time variance
- Efficiency variance excluding idle time.

Answer

The standard cost for direct labour is:
(18 minutes × 10/9) at $15 per hour
= 20 minutes at $15 per hour = $5.

It can be useful to separate the idle time part from 'active working hours', as follows:

	$
Active working hours: 18 minutes at $15 per hour	4.5
Idle time: 2 minutes at $15per hour	0.5
Total standard cost for direct labour	5.0

Total efficiency variance

The total efficiency variance, including the idle time variance, can be calculated as follows:

	hours	
3,600 units of output should take (× 20 minutes)	1,200	
They did take	1,000	
Total efficiency variance in hours	200	(F)
Standard direct labour rate per hour	$15	
Total direct labour efficiency variance in $	$3,000	(F)

This total variance can be analysed into an idle time variance and an 'efficiency variance excluding idle time', but there are two different methods of calculating the variance, each producing different values.

Idle time variance and efficiency variance excluding idle time: method 1

This is the method that we recommend, because we consider it to be both easier and also more meaningful in terms of the variances calculated.

With this method, the idle time variance is calculated by comparing the actual idle time with the idle time that would be expected in producing the units of output produced. The idle time variance is therefore related to the output produced.

Idle time variance, method 1	hours	
3,600 units of output: standard idle time (× 2 minutes)	120	
Actual idle time	70	
Idle time variance in hours	50	(F)
(Favourable because actual idle time less than expected)		
Standard direct labour rate per hour	$15	
Idle time variance in $	$750	(F)

The efficiency variance excluding idle time compares the time that it should have taken to make the output (excluding idle time) with the time that it did take to make them (excluding idle time).

Efficiency variance excluding idle time, method 1	**hours**	
3,600 units of output should take (× 18 minutes)	1,080	
They did take (1,000 hours worked less 70 hours of idle time)	930	
Efficiency variance in hours – exclluding idle time	150	(F)
Standard direct labour rate per hour	$15	
Efficiency variance in $, excluding idle time	$2,250	(F)

Labour efficiency variances: summary, method 1	**$**	
Idle time variance	750	(F)
Efficiency variance excluding idle time	2,250	(F)
Total labour efficiency variance	3,000	(F)

Idle time variance and efficiency variance excluding idle time: method 2

This method is more complex, and we recommend method 1 rather than method 2. With method 2, the idle time variance is calculated on the basis of actual hours worked and paid for (rather than on the basis of output produced), as follows.

Idle time variance, method 2	**hours**	
1,000 hours worked: expected idle time (10%)	100	
Actual idle time	70	
Idle time variance in hours	30	(F)
(Favourable because actual idle time less than expected)		
Standard direct labour rate per hour	$15	
Idle time variance in $	$450	(F)

The efficiency variance excluding idle time is now calculated as the difference between actual hours worked excluding idle time (= 1,000 hours – 70 hours = 930 hours) and the hours that it should have taken to produce the actual output after deducting the standard idle time for the hours worked.

Efficiency variance excluding idle time, method 2	**hours**	
3,600 units of output should take (× 20 minutes)	1,200	
Less: Standard idle time for the actual hours worked (10% × 1,000)	(100)	
	1,100	
They did take (1,000 hours worked less 70 hours of idle time)	930	
Efficiency variance in hours – exclluding idle time	170	(F)

Standard direct labour rate per hour	$15	
Efficiency variance in $, excluding idle time	$2,550	(F)

With this method, the actual meaning of the efficiency variance excluding idle time is difficult to understand. This is the main reason why we recommend method 1, although method 2 has been used as an acceptable method of calculation in the answer to a past F5 examination paper question.

Labour efficiency variances: summary, method 2	$	
Idle time variance	450	(F)
Efficiency variance excluding idle time	2,550	(F)
Total labour efficiency variance	3,000	(F)

Other aspects of basic variances

- Labour variances and the learning curve
- ABC-based variances

10 Other aspects of basic variances

10.1 Labour variances and the learning curve

When a learning curve is used in the budget process, it is not possible to calculate a standard direct labour cost for output. However it is possible to calculate a labour efficiency variance by comparing:

- the actual time taken to produce output during the period, with
- the time that it should have taken, allowing for the learning curve.

Example

A company has budgeted to make a new product. The expected time to make the first unit was 600 hours. An 80% learning curve is expected to apply. The budgeted direct labour cost is $20 per hour and the budgeted variable overhead costs are $4 per labour hour.

During the budget period, 5 units of the product were manufactured. The time required to make them was 1,850 hours.

What were the direct labour efficiency variance and the variable overhead efficiency variance for this product?

Answer

Using an 80% learning curve, the expected time to produce the first five units can be calculated as follows.
Average time per unit (cumulative) = ax^b

The factor b = log 0.80/log 2
= - 0.09691/0.30103
= - 0.3219.

The first unit was expected to take 600 hours.
The expected average time for the first 5 units was therefore: 600 × (1/$5^{0.3219}$).
= 600 × 0.59566 = 357.4 hours.

The efficiency variances can now be calculated as follows:

	hours	
5 units of output should take (× 357.4 hours)	1,787	
They did take	1,850	
Total efficiency variance in hours	63	(A)
Standard direct labour rate per hour	$20	
Labour efficiency variance in $	$1,260	(A)
Standard variable overhead rate per hour	$4	
Variable overhead efficiency variance in $	$252	(A)

10.2 ABC-based variances

When an entity used activity-based costing, variances can be reported for each activity. Many of the costs for an activity will be fixed, and for fixed costs we can calculate an expenditure variance for each period.

When some activity costs are variable, and these costs vary with the units of cost driver during the period, the calculation of the expenditure variance for each activity can also make allowance for the variable costs.

Example

A company uses activity-based costing. One of the activities is order handling, for which the cost driver is the number of orders handled. The expected costs of order handling are $90,000 per month plus $150 per order handled.

During one month, 400 orders were handled and the total cost of the activity was $132,000.

The expenditure variance for order handling can be calculated as follows:

Order handling expenditure variance	$	
Budgeted fixed costs	90,000	
Expected variable costs (400 orders × $150)	60,000	
Total expected costs	150,000	
Actual costs	132,000	
Expenditure variance	18,000	(F)

10.3 Deciding whether to investigate a variance

When a learning curve is used in the budget process, it is not possible to calculate a standard direct labour cost for output. However it is possible to calculate a labour efficiency variance by comparing:

Deciding whether to investigate a variance

- Management responses to reported variances
- Factors to consider
- Interdependence between variances
- Statistical control charts
- Cost-benefit analysis for variance investigation

11 Deciding whether to investigate a variance

11.1 Management responses to reported variances

When a variance is reported, the manager responsible must decide whether it should be investigated. The purpose of investigating a variance is to:

- find out the cause or causes of the variance
- decide whether the variance is 'controllable': a variance is controllable if management control action can be taken that will affect the amount of the variance in future periods
- if the variance is controllable, to decide whether any control action should be taken to deal with its cause.

Investigating the cause of a variance takes management time and can be costly. Management should not spend time and money on an investigation if the expected benefits are unlikely to exceed the costs.

The size of a reported variance can be misleading. For example, if a reported labour efficiency variance is $4,000 adverse, this does not mean that $4,000 can be saved by taking action to correct the cause of the adverse variance.

- The reported variance is a historical variance, and any control action can only affect the future, not what has already happened in the past.
- The reported variance shows how much actual costs were higher than expected because actual efficiency was worse than the expected standard of efficiency. However, this does not mean that control action will enable the entity to achieve standard efficiency in the future. For example, the standard might be an ideal standard, which means that the reported efficiency variance will almost certainly always be adverse.
- Control action should affect all periods in the future, so the effect of taking control action in response to a reported variance in one period could have an effect that lasts for several periods, or even years, into the future.

11.2 Factors to consider

Before making a decision whether to investigate a variance, the following factors should be considered:

- **Size of the variance**. As a general rule, the cause of a variance is more likely to be significant when the variance is large. For example, a sales volume variance that is $40,000 adverse will be considered more significant than a sales volume variance of $400 adverse. The larger the variance, the greater the potential benefit from investigation and control measures.
- **Favourable or adverse variance**. Significant controllable favourable variances should be investigated as well as adverse variances. However, more significance might be given by management to adverse variances than to favourable variances. Management might take the view that if a reported variance is favourable, no action is needed and the variance might continue to be favourable in future periods – and this is desirable. However, using the same logic, unless control action is taken to correct the cause of an adverse variance, adverse variances will continue in the future – and this is undesirable. For this reason, a fairly small adverse variance might be investigated, but a favourable variance of the same amount might not be investigated.
- **Probability that the cause of the variance will be controllable**. A decision whether or not to investigate the cause of a variance will also depend on the expectation of management that the cause of the variance will be controllable. For example, management might be aware that there has recently been a significant increase in the market price of a raw material, or an increase in pay rates for employees. If so, they might decide that reported adverse material price and labour rate variances shouldn't be investigated, because the main cause is already known and it is unlikely that any control measures can be taken that will be effective in reducing adverse price and rate variances in the future.
- **Costs and benefits of control action**. Investigating a variance has a cost in terms of both management time and expenditure. A variance should not be investigated unless the expected benefits exceed the costs of investigation and control. The benefits are the cost savings or other benefits that will be obtained in the future if the variance is found to have a controllable cause and control action is therefore taken.
- **Random variations in reported variances**. Management might take the view that a favourable or adverse variance in one month is due to random factors that will not recur next month. A decision might therefore be taken to do nothing in the current month about the variance, but to wait and see whether the same variance occurs again next month. If the variance is due to random factors, it should not happen again next month, and management can probably ignore it without risk.
- **Reliability of budgets and measurement systems**. Management might have a view about whether the variance is caused by poor planning and poor measurement systems, rather than by operational factors. If so, investigating the variance would be a waste of time and would be unlikely to lead to any cost savings.

11.3 Interdependence between variances

In some cases, individual variances should not be considered in isolation. The cause of one variance might be connected to the cause of another variance. For example:

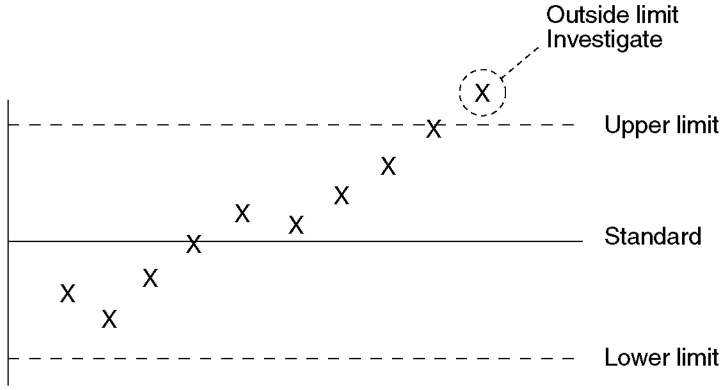
- An adverse materials usage variance might be caused by purchasing cheaper-than-normal materials (favourable price variance). If the quality of the materials is less than normal, higher rates of wastage or loss in production may occur.
- An adverse direct labour rate variance might be caused by using experienced workers who are more skilled but who are paid a higher rate. The employees might do the work more efficiently and more quickly (so there would be a favourable efficiency variance for labour and variable overheads) but there will be an adverse rate variance.
- Using unskilled workers to do a job might result in a favourable rate variance but an adverse efficiency variance. In addition, unskilled workers may cause higher wastage of materials, so that there may also be an adverse materials usage variance.
- A favourable sales volume variance might be the result of cutting prices (adverse sales price variance).
- Mix variances are described in the next chapter. However, there may be a connection between the total material usage variance in production (the material yield variance) and the mix of different materials used in production. Using a cheaper mix of materials in production will result in a favourable mix variance, but the consequence mat be inefficiency in material usage (an adverse yield variance).

The possibility of interdependence between variances means that if management decide to investigate one reported variance, they might find that they also have to investigate or more inter-related variances, to establish the cause of the variance and the possible benefits from control action.

11.4 Statistical control charts

Statistical control charts might be used for the assessment of variances and making a decision whether or not to investigate a reported variance.

- Control limits might be set for each variance, so that only variances that are an unusually large amount, and exceed the control limit, should be investigated.
- This could be plotted on a statistical control chart, with the control limits shown as ‘trigger limits’ for control action. The control limit for investigating a favourable variance could be a different size to the control limit for an adverse variance.



This statistical control chart shows reported variances over time. The variances recorded on the chart could be:

- The variance in each individual control period
- A cumulative total of variances, for example a 12-month rolling total for the variance. The variance should only be investigated if the cumulative total for the past 12 months exceeds the upper or lower control limit.

11.5 Cost-benefit analysis for variance investigation

The decision about whether or not to investigate a variance might be based on an assessment of:

- the costs of investigating the variance
- the probability that the cause of the variance will be a controllable factor
- the costs of control action if the cause is controllable
- the expected benefits from control action if the cause is controllable.

This method weighs up the expected value of the costs and the expected value of the benefits of investigating a variance.

The 'decision rule' for investigating a variance can be expressed as a formula.

The variance should be investigated if:

$I + pC < pB$

Where:

I = the cost of investigating the variance
C = the cost of correcting the cause of the variance, if the cause is found to be controllable
p = the probability that the cause of the variance will be controllable
B = the expected benefits from control action, if the cause of the variance is found to be controllable

Example

An adverse material usage variance of $1,400 has been reported.

The estimated cost of investigating the cause of a material usage variance is $800.

It is also estimated that if the cause of the variance is found, after investigation, to be controllable, the cost of taking control action would be $650.

The estimated benefits from control action, if the cause of the variance is found to be controllable, are $2,500.

The probability that the variance will be caused by a controllable factor is 60%.

Should the variance be investigated?

Answer

EV of costs of investigation = I + pC = \$800 + 0.60 (\$650) = \$1,190.

EV of benefits from investigation and control = pB = 0.6 × \$2,500 = \$1,500.

The EV of benefits exceed the EV of costs by \$310; therefore the variance should be investigated.

CHAPTER 11

Advanced variance analysis

Contents

Materials mix and yield variances

- Definition of materials mix and yield variances
- Calculating a direct materials mix variance
- Calculating a direct materials yield variance
- Changing the materials mix: factors to consider

1 Materials mix and yield variances

1.1 Definition of materials mix and yield variances

When standard costing is used for products which contain two or more items of direct material, the total materials usage variance can be analysed into a materials mix and a materials yield variance. However, mix and yield variances have a useful meaning only when the proportions (or 'mix') of the different raw materials in the final product can be varied and so are subject to management control

- The **total direct materials usage variance** is calculated by taking each item of direct material in turn, and calculating a materials usage variance in the normal way. The total direct material usage variance is the sum of the direct materials usage variance for each of the individual materials.
- The **materials mix variance** measures how much of this total variance is attributable to the fact that the actual combination or mixture of materials that was used was more expensive or less expensive than the standard mixture for the materials.
- The **materials yield variance** is a total usage variance for all the materials taken together, assuming that the materials are in the standard proportions or mix. It is calculated as a single figure, using the weighted average standard price per unit of material for the calculation of the variance.

The mix component of the usage variance therefore indicates the effect on costs of changing the combination (or mix or proportions) of material inputs in the production process.

The yield component indicates the effect on costs of the total materials inputs yielding more or less output than expected.

There is possible value for management, for control purposes, in calculating a mix variance and a yield variance, but only if they are in a position to control the mixture or proportions of the materials in the manufactured item.

1.2 Calculating a direct materials mix variance

There are two methods of calculating the mix variance. Both should provide exactly the same variance. You should use the method that you find easier to understand.

Method 1

- Take the total quantity of al the materials used and calculate what the quantities of each material in the mix should be if the total usage had been in the standard proportions or standard mix.
- Compare the actual quantities of each individual material that were used, and the standard quantities that would have been used (the standard mix) if the total usage had been in the standard proportions or standard mix.
- For each material, take the difference between the quantity in the actual mix used and the quantity in the standard mix. If actual usage is higher than standard usage, the variance is adverse. If actual usage is less than standard usage, the variance is favourable. The total mix variance *in material quantities* is always zero.
- Convert the mix variance for each individual material into a money value by multiplying by the standard price per unit of the material. Add the total mix variances for each material (money values) to obtain the total mix variance.
- If the actual mix used is more expensive than the standard mix, the total mix variance is adverse. If the actual mix used is cheaper than the standard mix, the total mix variance is adverse.

Example

Product N is produced from three direct materials that are mixed together in a process, materials A, B and C. The standard materials cost for product N is as follows:

Material	Quantity	Standard price per kilo	Standard cost
	kilos	$	$
A	1	20	20
B	1	22	22
C	8	6	48
	10		90

Actual output during month 6 amounted to 200 units of product N in total. Actual usage of each material was as follows:

Material	kilos
A	160
B	180
C	1,760
	2,100

Required

Calculate the direct materials mix variance for month 6.

Answer

The total quantity used was 2,100 kilos. This total usage can be divided into a standard mix for materials A, B and C and the standard mix and actual mix can be compared, as follows.

Material	Actual mix		Standard mix	Mix variance in quantities		Standard price per kilo	Mix variance in value	
	kilos		kilos	kilos		$	$	
A	160	(1)	210	50	(F)	20	1,000	(F)
B	180	(1)	210	30	(F)	22	660	(F)
C	1,760	(8)	1,680	80	(A)	6	480	(A)
	2,100		2,100	0			1,180	(F)

For each individual item of material, the mix variance is favourable when the actual mix is less than the standard mix, and the mix variance is adverse when actual usage exceeds the standard mix.

The **total mix variance** is favourable in this example because the actual mix of materials used is cheaper than the standard mix.

Method 2

Method 2 produces the same value for the mix variance.

- Take the total quantity of materials used.
- For each material, calculate a mix variance in quantities, the same as for method 1. However, do not decide yet whether the variance is adverse or favourable for each material.
- Next, calculate the weighted average price per unit of materials in the mix. This is calculated as [the total direct materials cost per unit divided by the total number of units of materials in one unit of finished product].
- For each material, calculate the difference between the standard price for the material and the weighted average standard price.
- A cheap material is a material whose standard price is lower than the weighted average standard price for materials in the mix.
- An expensive material is a material whose standard price is higher than the weighted average standard price for materials in the mix.
- Next, for each material in the mix, multiply the mix variance in quantities by the difference between its standard price and the weighted average standard price. Decide whether the variance for each material is favourable or adverse.
  - If there is more of a cheap material in the actual mix than in the standard mix, the variance for the material is favourable.
  - If there is less of a cheap material in the actual mix than in the standard mix, the variance for the material is adverse.
  - If there is more of an expensive material in the actual mix than in the standard mix, the variance for the material is adverse.

   - If there is less of an expensive material in the actual mix than in the standard mix, the variance for the material is favourable.
- The total mix variance is calculated by adding the mix variance for each individual material.

Example

Calculate the materials mix in the previous example, using method 2.

Answer

The weighted average standard cost per kilo of material = $\frac{\$90}{10}$ kilos = $9 per kilo.

Material	Actual mix		Standard mix	Mix variance in quantities	Standard price per kilo minus weighted average standard price	Mix variance in value	
	kilos		kilos	kilos	$	$	
A	160	(1)	210	50	(20 – 9) = 11	550	(F)
B	180	(1)	210	30	(22 – 9) = 13	390	(F)
C	1,760	(8)	1,680	80	(6 – 9) = 3	240	(A)
	2,100		2,100	0		1,180	(F)

Notes

(1) The mix variance for material A is favourable. This is because material A is an expensive material (its standard price of $20 is higher than the weighted average standard cost for the mix of $9). The actual usage of this expensive material is less than the standard mix usage; therefore the mix variance for material A is favourable.

(2) The mix variance for material B is also favourable, for similar reasons.

(3) The mix variance for material C is also favourable. This is because material C is a cheap material (its standard price of $6 is lower than the weighted average standard cost for the mix of $9). The actual usage of this expensive material is more than the standard mix usage; therefore the mix variance for material C is favourable.

The total mix variance of $1,180 (F) is the same as with method 1.

1.3 Calculating a direct materials yield variance

The direct materials yield variance is a total usage variance for all items of direct materials.

- A materials usage variance is calculated for each item of materials individually.
- A yield variance is calculated for all materials in total. It is converted into a money value at the weighted average standard price per unit of materials.

A yield variance is calculated as follows:

		Total material quantities	
Actual quantity of units produced	should use	X	
	did use	Y	
Yield variance in quantities		(X – Y)	(F) or (A)
× Weighted average standard price per unit of material		$P	
Yield variance in money value		P x (X – Y)	(F) or (A)

Example

Product N is produced from three direct materials that are mixed together in a process, material materials A, B and C. The standard cost card for product N is as follows:

Material	Quantity	Standard price per kilo	Standard cost
	kilos	$	$
A	1	20	20
B	1	22	22
C	8	6	48
	10		90

Actual output during month 6 amounted to 200 units of product N in total. Actual usage of each material was as follows:

Material	kilos
A	160
B	180
C	1,760
	2,100

Required

Calculate the direct materials yield variance for month 6, and prove that the mix and yield variances add up to the total usage variance.

a

Answer

Working

The weighted average standard cost per kilo of material = $\frac{\$90}{10}$ kilos = $9 per kilo.

		kilos	
200 units of product N	should use (× 10 kilos)	2,000	
	did use	2,100	
Yield variance in quantities		100	(A)
× Weighted average standard price per unit of material = $9			
Yield variance in money value		= $900	(A)

The materials usage variance (which is the sum of the mix and yield variances) is calculated for each item of material individually, as follows.

Material	To make 200 units of N Did use	Should use	Variance in quantitiy	Standard price per kilo	Usage variance	
	kilos	kilos	kilos	$	$	
A	160	200	40 (F)	20	800	(F)
B	180	200	20 (F)	22	440	(F)
C	1,760	1,600	160 (A)	6	960	(A)
					280	(F)

The mix variance was calculated previously and is $1,180 (F). The variances can be summarised as follows:

Summary

	$	
Mix variance	1,180	(F)
Yield variance	900	(A)
Usage variance (= mix + yield variances)	280	(F)

1.4 Changing the materials mix: factors to consider

Analysis of the material usage variance into the mix and yield components is worthwhile if management have control of the proportion of each material used. Management will seek to find the optimum mix for the product and ensure that the process operates as near to this optimum as possible.

Identification of the optimum mix involves consideration of several factors:

- Cost. The cheapest mix may not be the most cost effective. Often a favourable mix variance is offset by an adverse yield variance and the total cost per unit may increase.
- Quality. Using a cheaper mix may result in a lower quality product and the customer may not be prepared to pay the same price. A cheaper product may also result in higher sales returns and loss of repeat business.

Planning and operational variances

- The reasons for planning and operational variances
- Ex ante and ex post standards or budgets
- Using ex post standards (or ex post budgets) to calculate planning and operational variances
- Calculating planning and operational variances
- Comparing planning and operational variances with traditional variances
- More than one difference between the ex ante and ex post standard costs
- Advantages and disadvantages of using planning and operational variances
- Manipulation issues in revising budgets

2 Planning and operational variances

2.1 The reasons for planning and operational variances

The purpose of reporting variances is to inform management of any differences between budgeted and actual results, or between standard costs and actual costs. Managers can use information about variances to identify problems that should be investigated, and where appropriate:

- take control action to correct adverse results or
- take measures to exploit favourable results.

The effectiveness of variance reporting, and the effectiveness of control management based on variance reports, depends on reliable budgets and standards. It is essential that the budget or standard cost must be reasonable, because variances are calculated as the difference between actual results and the budget or standard.

If the budget or standard is unreliable, the variance reports will also be unreliable – and so useless for management.

2.2 Ex ante and ex post standards or budgets

If management decide that the standard cost is unreliable and invalid, they can prepare a more realistic or accurate standard cost. Similarly, if the original budget is invalid, a more realistic budget can be prepared.

- The original standard cost or budget is known as the **ex ante standard or ex ante budget**.
- The revised and more realistic standard cost or budget is known as the **ex post standard or ex post budget**.

2.3 Using ex post standards (or ex post budgets) to calculate planning and operational variances

Ex post standards or budgets can be used to calculate variances, as an alternative to the 'normal' method of calculating variances.

- Actual results are compared with the ex post standard (or ex post budget) and variances are calculated using the ex post standard. These variances are the **operational variances.**
- The ex post standard cost (or ex post budget) is compared with the ex ante standard cost (or ex ante budget) and the difference between them is the **planning variance**.

The planning variance is therefore a measurement of the amount by which an unreliable standard cost (or unreliable budget) – in other words, poor planning or a major revision to plans – is the cause of the difference between actual results and the original ex ante standard cost or ex ante budget. **Planning variances are uncontrollable,** in the sense that control action by management will not eliminate a weakness in planning.

The operational variances, by comparing actual results with a realistic standard cost, provide useful control information for management. **Operational variances may be controllable variances**.

2.4 Calculating planning and operational variances

Planning and operational variances can be calculated for any aspect of a standard cost or budget: for example, an ex post standard cost can be calculated for the direct materials cost per unit, or the direct materials usage per unit, or the direct materials price per unit, or the direct labour cost per unit, the direct labour hours per unit, and so on.

Similarly, an ex post budget can be prepared with revised figures for sales volumes or sales prices.

The following example will be used to illustrate the basic method of calculating planning and operational variances.

Example

Product Z has a standard labour cost of 3 hours per unit at $8 per hour = $24 per unit.

During the first month of the current year, 500 units of Product Z were manufactured. These took 1,960 hours to make, at a labour cost of $16,500.

Using **traditional variances**, the labour variances for the month would be as follows:

Labour rate variance	**$**	
1,960 hours should cost (× $8)	15,680	
But they did cost	16,500	
Labour rate variance	820	(A)

Labour efficiency variance	**hours**	
500 units of product Z should take (× 3 hours)	1,500	
But they did take	1,960	
Efficiency variance in hours	460	(A)
Standard labour rate per hour	$8	
Efficiency variance in $	$3,680	(A)

The **total labour cost variance** is $820 (A) + $3,680 (A) = $4,500 (A).

Suppose, however, that it is discovered early during the month that the planned improvements in efficiency that were expected from introducing new equipment could not be achieved, because the new equipment had suffered a major breakdown and had been returned to the supplier for repair.

It is decided that a more appropriate labour cost for each unit of Product Z should be:

4 hours × $8 per hour = $32.

This is accepted as a **new ex post standard cost** for direct labour cost.

A planning variance compares the difference between:

- the original standard cost or budget (the ex ante standard cost or ex ante budget), and
- the revised standard cost or budget (the ex post standard cost or ex post budget).

The planning variance is reported as the effect that this difference has had on reported profit or cost.

In this example, the planning variance applies to the labour hours per unit, but it can be calculated either on a labour cost per unit basis or a labour hours basis.

Since direct labour is a variable cost, the planning variance is calculated as the difference between:

- the standard labour cost with the ex ante standard, and
- the standard labour cost with the ex post standard.

Method 1

Total labour cost for 500 units of Z	$	
Ex ante standard cost (× $24)	12,000	
Ex post standard cost (× $32)	16,000	
Planning variance: labour efficiency	4,000	(A)

The planning variance is adverse because the ex post standard cost is less favourable (is more costly) than the ex ante standard cost.

Method 2

Since the planning error is in the labour hours per unit, the planning variance can be calculated in labour hours:

Labour hours: time required to make 500 units of product Z	hours	
Ex ante standard (× 3 hours)	1,500	
Ex post standard (× 4 hours)	2,000	
Planning variance in standard hours	500	(A)
Standard labour rate per hour	$8	
Planning variance in $, labour efficiency	$4,000	(A)

Operating variances are calculated in the same way as traditional variances, except that the ex post standard cost (or ex post budget) is used, not the ex ante standard cost.

In this example, only the labour efficiency variance is affected by the change. The labour rate variance remains at $820(A). The operating variance for labour efficiency is calculated as follows:

Labour efficiency (operating) variance	Hours	
500 units of product Z should take (× 4 hours)	2,000	
But they did take	1,960	
Efficiency variance in hours	40	(F)
Standard labour rate per hour	$8	
Efficiency variance in $ (operating variance)	$320	(F)

2.5 Comparing planning and operational variances with traditional variances

The planning and operating variances in the previous example can be summarised as follows:

	$		$	
Planning variance:				
Labour efficiency			4,000	(A)
Operating variances				
Labour rate	820	(A)		
Labour efficiency	320	(F)		
			500	(A)
Total direct labour variances			4,500	(A)

This compares with the traditional variances, which are:

	$	
Labour efficiency	3,680	(A)
Labour rate	820	(A)
Total direct labour variances	4,500	(A)

The total variances come to the same amount.

However, it can be argued that planning and operational variances provide much more useful control information to management than the traditional variances, because the original (ex ante) standard cost is unreliable and incorrect.

2.6 More than one difference between the ex ante and ex post standard costs

A situation could arise where there are planning errors or planning changes in two parts of the ex ante standard cost, and the errors both relate to:

- direct materials cost – with a planning variance in the standard material price and another planning variance in the standard material usage per unit.
- direct labour cost – with a planning variance in the standard labour rate per hour and another planning variance in the standard labour hours per unit.

In these circumstances, the planning variance can be analysed to show the effect of each separate planning variance.

The principle to apply in calculating the planning and operating variances is the same as if there is just one planning error in the standard cost.

- The planning variance in total is the difference between the ex ante standard cost and the ex post standard cost.

- The operating variances are calculated using the ex post standard cost.

The only difference is that if the total planning variance is caused by two factors, it should be possible to analyse the total planning variance into its different causes. The method of analysing a total planning variance will be explained with an example.

e

Example

Greenco manufactures product G, which has a standard direct material cost per unit of: 5 kilos at $6 per kilo = $30.

Actual output during a month is 4,000 units of product G, and the materials actually used in production were 16,500 kilos at a cost of $119,000.

The operations manager of Greenco persuades his colleagues that the standard cost for direct materials is incorrect, and a more realistic standard cost is:

4 kilos at $7 per kilo = $28.

Required: Analyse the total planning variance for materials cost into a planning variance for materials price and a planning variance for materials usage.

a

Answer

Total planning variance

The planning variance is caused by two factors, an incorrect price per kilo and an incorrect usage quantity per unit of output. However, the total planning variance is calculated in the same way as shown previously (method 1).

Total material cost for 4,000 units of G	**$**	
Ex ante standard cost (× $30)	120,000	
Ex post standard cost (× $28)	112,000	
Planning variance, materials	8,000	(F)

The planning variance is favourable because the ex post standard cost is more favourable (is less costly) than the ex ante standard cost.

Further analysis of the total planning variance

The total planning variance can be analysed into a planning variance caused by each planning change in the standard – in this example there is an error in the standard for materials price and an error in the standard for materials usage and we can therefore analyse the total planning variance for materials into a planning variance for materials price and a planning variance for materials usage.

The two standard costs that we are comparing are as follows:

Ex ante standard	4,000 units × 5 kilos = 20,000 kilos × $6	$120,000
Ex post standard	4,000 units × 4 kilos = 16,000 kilos × $7	$112,000

The planning variance for materials price is \$7 - \$6 per kilo = \$1 per kilo. It is an adverse variance, because the ex-post standard for materials price is more costly than the ex-ante standard.

The planning variance for materials usage is 5 kilos – 4 kilos = 1 kilo per unit produced, which is 4,000 kilos in total for 4,000 units produced. It is a favourable variance, because the ex-post standard for materials usage per unit is less costly than the ex-ante standard.

Planning variance caused by the material price difference

Unfortunately, there are two methods of calculating the planning variances for price and usage.

Planning variance for materials price

(1) Method 1: Price planning variance per kilo × Standard usage in ex-post standard

(2) Method 2: Price planning variance per kilo × Standard usage in ex-ante standard

Planning variance for materials usage

(3) Method 1: Usage planning variance = Planning variance per unit produced × Standard price in ex-ante standard

(4) Method 2: Usage planning variance = Planning variance per unit produced × Standard price in ex-post standard

To avoid double-counting, method (1) for the material price planning variance must be used with method 1 for the materials usage planning variance. Similarly method (2) for the material price planning variance must be used with method 2 for the materials usage planning variance.

In the example above:

Planning variance	**Method 1**	\$		**Method 2**	\$	
Price	\$1 per kilo (A) × 16,000 kilos	16,000	(A)	\$1 per kilo (A) × 20,000 kilos	20,000	(A)
Usage	4,000 kilos (F) × \$6	24,000	(F)	4,000 kilos (F) × \$7	28,000	(F)
Total		8,000	(F)		8,000	(F)

A final example of planning and operational variances will be used to summarise the rules.

Example

Redco manufactures product K, which at the start of the budget period had a standard direct labour cost per unit of: 0.3 hours per unit × \$16 per hour = \$4.80.

Actual output during a month is 10,000 units of product K, and these took hours to make. The actual direct labour cost was \$.

Due to an unexpected pay agreement with the direct labour employees, the standard rate per hour is revised to $20. In addition, since the pay rise is linked to a productivity agreement, the standard time per unit of product K is reduced to 0.25 hours. The revised standard labour cost for product K is therefore:

0.25 hours × $20 per hour = $5.

Actual output during a subsequent month is 10,000 units of product K, and these took 2,650 hours to make. The actual direct labour cost was $51,600.

Required:
(a) Analyse the total direct labour variance into operational variances and a planning variance.
(b) Then analyse the total planning variance into a planning variance for labour rate and a planning variance for labour efficiency.

a

Answer

Operational variances

These are calculated by comparing actual results with the ex-post standard.

Labour rate variance (operational variance)	$	
2,650 hours should cost (× $20)	53,000	
They did cost	51,600	
Direct labour rate variance	1,400	(F)

Labour efficiency variance (operational variance)	**hours**	
10,000 units should take (× 0.25 hours)	2,500	
They did take	2,650	
Efficiency variance in hours	150	(A)
Standard direct labour rate per hour	$20	
Direct labour efficiency variance in $	$3,000	(A)

Total planning variance

		$	
Ex ante standard	10,000 units × 0.30 hours = 3,000 hours × $16 per hour	48,000	
Ex post standard	10,000 units × 0.25 hours = 2,500 hours × $20 per hour	50,000	
Total planning variance for labour		2,000	(A)

The planning variance is adverse because the ex post standard cost is higher than the ex ante standard cost.

Summary, planning and operational variances	**$**	
Operational variances		
Lasbour rate	1,400	(F)
Labour efficiency	3,000	(A)
Total operational variances	1,600	(A)
Labour cost planning variance: total	2,000	(A)
Total labour cost variances	3,600	(A)

The total variance is the difference between the ex ante standard labour cost (= $48,000) and actual labour costs ($51,600).

Analysing the total planning variance

The total planning variance can be calculated in two ways:

Planning variance	**Method 1**	$		**Method 2**	$	
Rate	$4 per hour (A) × 2,500 hours	10,000	(A)	$4 per hour (A) × 3,000 hours	12,000	(A)
Efficiency	500 hours (F) × $16 per hour	8,000	(F)	500 hours (F) × $20 per hour	10,000	(F)
Total		2,000	(A)		2,000	(A)

2.7 Advantages and disadvantages of using planning and operational variances

There are several advantages and disadvantages to using planning and operational variances.

Advantages

- They identify variances due to poor planning and put a realistic value to variances resulting from operations.
- Planning variances can be used to update standard costs and revise budgets.
- The performance of managers is assessed on 'realistic' variance calculations, using ex post standard costs that are more realistic than ex ante standard costs.

Disadvantages

- They are based on the assumption that planning will be inaccurate or unrealistic. This should occur only occasionally, not regularly.
- It takes time and effort to prepare ex post standard costs and to revise budgets.

- Managers might try to blame poor results on poor planning and not on their operational performance.

2.8 Manipulation issues in revising budgets

When variances are reported as planning and operational variances, operational managers are likely to be:

- made accountable for operational variances
- not made accountable for planning variances.

It is not possible to take control action to rectify the causes of planning variances (except perhaps by improving planning procedures next year).

If managers are help responsible for operational variances but not planning variances, there will be a temptation to 'manipulate' the standard cost or budget by revising it so that:

- the 'ex post' standard cost is higher than the ex ante standard cost (so there will be an adverse planning variance)
- the revised budgeted profit is lower than the ex ante budget profit (so there will be an adverse planning variance).

By revising the standard cost or budget in this way, to create adverse planning variances, the operational variances will be improved. Any adverse operational variance using the ex ante standard will be:

- reduced using the ex post standard, or
- possibly turned into a favourable variance using the ex post standard.

This risk, that operational managers improving their operational variances by revising the standard cost or budget, should be kept under control. There are two ways that this might be done:

- A revision to the standard cost or budget should be permitted only in circumstances where the reasons for the change in the standard cost or budget are outside the control of operational management. For example, a revision to materials prices maybe allowed if the market price of a key raw material (such as the cost of oil or the cost of a commodity) increases to a level far in excess of the budgeted price.
- Changes that may be subject to management influence and control should not be included in a revision to the budget.

Market size and market share variances

- The meaning of market size and market share variances
- Market size variance
- Market share variance
- Performance measurement and market size and market share variances

3 Market size and market share variances

3.1 The meaning of market size and market share variances

Just as standard cost variances can be analysed into planning and operational variances by preparing an ex post standard cost, sales volume variances can be analysed into planning and operational variances by producing an ex post sales budget.

However, in analysing a sales volume variance:

- the planning variance for sales volume is called a **market size variance** and
- the operational variance for sales volume is called the **market share variance**.

However, a market size and a market share variance can be calculated without any requirement to revise the sales budget.

When a budget is prepared for sales volume, the estimate of sales volume is based on several estimates or assumptions:

- There maybe an estimate of the total size of the market for the product during the period. This is the estimated amount of sales in total for the market or market segment, including the sales made by competitors.
- Within this estimate of total market size, the entity may budget the share of the market that it will obtain.

For example, a company may estimate that the total market size for a product in the next year will be 100,000 units or $2 million, and it may estimate that it will obtain 30% of the total market. Its sales budget for the year would therefore be 30,000 units or $600,000.

Actual sales might be just 28,000 units. The reasons could be either that:
The total market size was less than 100,000 units (market size variance), or
The market share obtained by the company was less than 30% (market share variance)

A value can be calculated for the market size and market share variances and the sum of these two variances will be equal to the total sales volume variance for the period.

Controllability of market size and market share variances

It might also be assumed that:

- The total size of the market is a factor that is largely outside a company's control.
- However the market share obtained by a company is controllable to some extent by management, through marketing activities such as advertising, direct selling, distribution arrangements, after-sales service and price incentives (bulk order discounts, competitive pricing, and so on).

3.2 Market size variance

A market size variance is the effect on sales volume (and so on contribution or profit) if the actual total size of the market is:

- larger than expected (favourable market size variance), or
- smaller than expected (adverse market size variance).

The total difference between the budgeted total market size and the actual total market size is calculated initially either in (1) units of sale or (2) sales revenue at standard selling prices.

- It is assumed that the company should achieve its budgeted market share.
- The market size variance for the company is therefore (in units or in sales revenue at standard sales price) the difference in the total market size multiplied by the estimated market share.
- This is then converted into an amount of standard contribution or standard profit, using the same method used to calculate the sales volume variance.

Example

Colorco set the following sales budget:

Sales of Product Y = 43,000 units
Contribution per unit = $20
Colorco estimates that the total size of the market in the budget period will be 700,000 units. It budgets to have a market share of 10% or 70,000 units.

Actual sales results for the period were as follows:

Sales of Product Y by Colorco = 58,000 units
Total market sales of Product Y = 645,000 units

In retrospect, it is accepted that the budget should have been based on a total market share of 645,000 units.
Required
Calculate the market size variance for the year.

Answer

Market size variance	units	
Ex ante (budgeted) total market size	700,000	
Ex post (actual) total market size	645,000	
Total difference	55,000	(A)
Budgeted market share	10%	
Market size variance (units)	5,500	(A)
Standard contribution per unit	$20	
Market size variance in $ contribution	$110,000	(A)

3.3 Market share variance

A market share variance is calculated by taking the actual total market size (the ex post estimate of the market size) and comparing:

- the expected sales volume, if the budgeted market share had been achieved, and
- actual sales volume.

This variance (in sales units or in sales revenue at standard sales price) is converted into a contribution or profit variance using the same method used to calculate the sales volume variance.

Example

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Sales of Product Y by Colorco = 58,000 units
Total market sales of Product Y = 645,000 units

In retrospect, it is accepted that the budget should have been based on a total market share of 645,000 units.

Required

Calculate the market share variance for the year.

Answer

Market share variance	units	
Ex post (actual) total market size	645,000	
Budgeted market share	10%	
	units	
Expected sales if budgeted market share achieved	64,500	
Actual sales	58,000	
Market shae variance (units)	6,500	(A)
Standard contribution per unit	$20	
Market share variance in $ contribution	$130,000	(A)

Summary

	$	
Market size variance	110,000	(A)
Market share variance	130,000	(A)
Total sales volume variance (70,000 units – 58,000 units) × $20 per unit	240,000	(A)

The market size variance and the market share variance together add up to the total sales volume variance for the period.

A final example is given below.

Example

The sales budget of Brunco was based on the following estimates:

Total size of market: 200,000 units
Expected market share: 25%
Standard contribution per unit $40

At the end of the year it was estimated that the actual size of the market during the year had been 260,000 units.

Actual sales in the year were 61,000 units.

Required

Calculate for the year:

(a) the total sales volume variance

(b) the market size variance

(c) the market share variance.

Answer

	units	
Budgeted sales volume (25% × 200,000)	50,000	
Actual sales volume	61,000	
Sales volume variance in units	11,000	(F)
Standard contribution per unit	$40	
Sales volume variance in $ contribution	$440,000	(F)

Market size variance	**units**	
Ex ante (budgeted) total market size	200,000	
Ex post (actual) total market size	260,000	
Total difference	60,000	(F)
Budgeted market share	25%	
Market size variance (in units)	15,000	(F)
Standard contribution per unit	$40	
Market size variance in $ contribution	$600,000	(F)

Market share variance	units	
Ex post (actual) total market size	260,000	
Budgeted market share	25%	
	units	
Expected sales if budgeted market share achieved	65,000	
Actual sales	61,000	
Market share variance (units)	4,000	(A)
Standard contribution per unit	$40	
Market share variance in $ contribution	$160,000	(A)

Summary

	$	
Market size variance	600,000	(F)
Market share variance	160,000	(A)
Total sales volume variance	440,000	(F)

3.4 Performance measurement and market size and market share variances

For your examination, you must be able to interpret and comment on market size and market share variances, as well as calculate them correctly. Variances are intended to provide indicators of performance, for the purposes of performance assessment and management control.

Market size and market share variances, together with the sales price variance, can indicate how well or badly a company is performing given current conditions in its market. As a general guide, it is useful to remember that in a competitive market, management:

- are unlikely to have any control over the total market size, but
- could have some control over market share, by means of marketing measures such as improved selling methods and sales price initiatives.

To assess a company's performance, it might therefore be useful to look at:

- whether the total market size is bigger or smaller than budgeted, and
- whether the company has achieved a larger or smaller share of the market than budgeted.

Losing market share in a growing market could be a cause for concern and a sign of poor performance. Gaining market share in a shrinking market could indicate excellent performance in difficult business conditions.

e

Example

A company reported the following variances for the year just ended:

Sales price variance: $145,000 (A)

Sales volume variance: $180,000 (A)

Market size variance: $290,000 (A)

Market share variance: $110,000 (F)

The company operates in a highly competitive market, but the market has been affected by an economic recession and a significant fall in total demand. During the year it achieved a 25% share of the total market. One competitor went into liquidation during the year.

How might performance be assessed on the basis of this information?

a

Answer

The market has been badly affected by an economic recession and the company has reported an adverse sales price variance and an adverse sales volume variance, totalling $325,000(A). Actual profit is therefore $325,000 less than budgeted profit because sales prices and sales volume were worse than expected.

The adverse sales price variance could be explained largely by the fact that in a competitive market that is affected by recession, all companies might be reducing their selling prices in an attempt to achieve sales.

The market size variance is $290,000(A), indicating that there has been a large fall in the size of the market due to the adverse economic conditions. However, the company has succeeded to some extent in reducing the damaging effect of the fall in market size by gaining a larger share of the market (market share variance $110,000(F)).

It is not clear, however, whether the improvement in market share is due to management effort (good performance) or due to the fact that a competitor went into liquidation – so that the competitor's share of the market is taken up by the companies that remain.

This example illustrates the level of analytical ability that you might be required to show in your examination. The examiner has stated (Student Accountant, May 2008) that:

- Calculating a variance or ratio alone is not enough to pass the exam
- Some interpretation or analysis is required, and you should use any background information given in the question
- You should hypothesise – suggest reasons – for the performance indicated by the variance or ratio: why might a variance be favourable or adverse?
- You will be expected to express an opinion. Comments such as: 'I recommend that management should investigate the cause of the variance…' will not be good enough.

Behavioural aspects of standard costing

- The effect of variances on staff motivation and action
- Behavioural aspect of variances in a TQM or JIT environment
- Standard costs in a rapidly changing environment

4 Behavioural aspects of standard costing

This section considers briefly some behavioural aspects of variance reporting. The behavioural issues to consider are:

- Whether managers and the staff in the entity respond to reported variances, and
- If they do respond, whether their response benefits the entity or might be harmful.

4.1 The effect of variances on staff motivation and action

In principle, when variances are reported the staff responsible should investigate the causes of variances that appear to be significant, and if it is discovered on investigation that the cause of the variance can be controlled, suitable control action should be taken.

This response by staff is only likely to happen under certain conditions:

- Senior managers should indicate the importance they attach to variance reports, and should demand explanations from their subordinates about significant variances and what has been done to investigate them. Subordinates are unlikely to treat variances seriously unless their boss does.
- Reported variances must be **realistic and reliable**. Staff will be reluctant to investigate variances if they do not trust the reported figures and consider the variances to be unrealistic.
- The standard cost or budget should be realistic and achievable.
- The possible causes of a variance should be controllable by the person who is made responsible and accountable for the variance. If the cause of a variance is unlikely to be controllable, it would be a waste of time to investigate its cause.
- Variances should be fairly current. If variance reports are not provided to management until several weeks after the control period, the variances might be considered 'out of date' and so 'no longer relevant'.
- If managers and other staff are given incentives for achieving favourable variances – for example if an annual cash bonus depends partly or entirely on achieving favourable variances – the individuals concerned should be motivated by performance and variance reports.

4.2 Behavioural aspect of variances in a TQM or JIT environment

Variances and a TQM environment

The concept of Total Quality Management (TQM) was first developed in Japan. As its name suggests, TQM is an approach to management based on the principle that all aspects of quality in an entity's operations should be managed so as to improve value for the customer.

One aspect of TQM is the concept of 'continuous improvement'. This is a view that in order to manage quality it is essential to keep looking for and identifying ways of improving quality in procedures, systems, products and services. Most improvements will be fairly small, but they should be happening all the time. Over time, a large number of small quality improvements will result in significant total improvements.

It has been suggested that variance analysis and variance reporting is inconsistent with TQM. This is because:

- Variances are calculated by comparing actual results with a fixed standard: performance is considered 'good' if actual results are better than the standard
- In a system of TQM, it is inappropriate to think in terms of a fixed standard, because the aim should be to improve continually. In a TQM environment, it would be disappointing if actual results are ever worse than standard (assuming that a current standard as at the start of the year is used for measuring variances).

Variance reporting in a TQM environment may lead to dysfunctional behaviour if managers ignore aspects of performance where the variance is close to $0, because in TQM any aspect of performance should be considered capable of improvement.

Variances and a JIT environment

Just in time (JIT) management involves purchasing raw materials and producing output 'just in time' for when they are needed.

- With JIT purchasing, the aim should be to obtain raw materials from suppliers only when the materials are needed for production.
- With JIT production, the aim should be to produce output only when there is a customer for the finished output.

In principle, in a JIT environment there will be no inventory of raw materials or finished goods. (In practice the aim should be to keep these inventories as low as possible).

This approach to management may possibly be inconsistent with some variance reporting, especially if a system of absorption standard costing is used.

- In a system of absorption costing, there will be favourable fixed production overhead variances if actual output exceeds budgeted output. In other words, favourable variances are obtained and profit is improved by increasing finished goods inventory levels.

- A consequence of JIT purchasing and production is that sometimes the purchase price for raw materials or the production cost for finished goods may be higher than they might otherwise be, because a supplier may charge a higher unit price for a small quantity. Production costs per unit may also be higher when batch sizes are smaller. With variance reporting, the aim would be to reduce material price variances and production cost variances; however in a JIT environment, it is considered that other benefits – not measured in variances – are greater. Variance reporting could therefore be inconsistent with JIT.

4.3 Standard costs in a rapidly-changing environment

Some business entities operate in a business environment where change is continual and fast. The life cycle of products may be short because of rapidly-changing technologies, and products may be developed or re-designed regularly, with new production methods. As new technologies develop and become popular, the market size might grow but sales prices are likely to fall.

There are many examples of industries in a rapidly-changing environment; for example mobile phone technology has changed enormously within a relatively small number of years, so that we now have touch screen technology and small handsets. Over time, the materials content of mobile phones has diminished, sales volumes have rocketed and sales prices have fallen substantially.

Standard costs may be incompatible with rapid change, for similar reasons to those explained for TQM.

- With variance analysis, actual results are compared with a fixed standard and a budget, and variances arise when actual results differ from the standard or budget.
- In a rapidly-changing environment, it should be expected that the original standard or budget may get out of date, and action to try to eliminate an adverse variance may in fact be inappropriate because operating conditions have now changed.

In conclusion, it may be argued that standard costing and variance analysis are now much less important for budgetary control than they may have been in the past.

- Standard costing and variances are most useful in conditions where standard products are made and sold. However, many companies now produce non-standard products, and try to adjust their products to the individual needs of particular customers. Even where companies do not customise products for individual customers, there is extensive fragmentation of markets into segments or niches, with different product designs manufactured for each separate segment.
- As suggested above, variance reporting and budgetary control based on variances may not be appropriate for many modern manufacturing environments, such as those where TQM or JIT methods are applied.
- Similarly, variance reporting may be inappropriate in a rapidly-changing business environment.

CHAPTER 12

The scope of performance measurement

Contents

Measuring performance

- Reasons for measuring performance
- Responsibility and controllability
- Long-term, medium-term and short-term performance
- Financial and non-financial performance measures
- Performance measurement and the F5 examination
- Benchmarking

1 Measuring performance

1.1 Reasons for measuring performance

Performance in business should be measured and reported back to:

- the individuals most directly responsible for the performance
- their boss or bosses.

The purpose of measuring performance is to:

- inform individuals whether the planning targets or standards (for which they are responsible) are being met
- inform senior managers about the performance of each of their subordinates, as well as their own performance
- indicate the risk that targets will not be met, so that action to correct the situation can be considered
- indicate poor performance, so that individuals and their managers can take whatever corrective action seems appropriate
- reward the successful achievement of targets or standards, for example by means of cash bonuses or other incentives.

A business entity must have management information systems that are capable of providing reliable and relevant information about all the important aspects of performance.

1.2 Responsibility and controllability

Two essential features of an effective performance reporting system are:

- **Responsibility**. Performance reports should be provided to the individuals (and their managers) who are actually responsible for the performance. Performance reports are irrelevant if they are sent to individuals with no responsibility.
- **Controllability**. Performance reports should distinguish between aspects of performance that should be controllable by the individual who is made responsible and accountable. There is no sensible purpose in judging the

performance of an individual by looking at factors that are outside the individual's control.

1.3 Long-term, medium-term and short-term performance

Performance measurement should cover the long-term, medium-term and short-term.

Long-term performance

Long-term performance measures should be linked to the long-term objectives and the strategies of the organisation. The most significant long-term objectives might be called **critical success factors** or **CSFs**. In order to achieve its long-term and strategic objectives, the critical success factors must be achieved.

For each critical success factor, there should be a way of measuring performance, in order to check whether the CSF targets are being met. Performance measurements for CSFs might be called **key performance indicators (KPIs)** or possibly **key risk indicators** (KRIs).

Medium-term performance

Medium-term performance measurement is perhaps most easily associated with the annual budget, and meeting budget targets. Targets, whether financial or non-financial, can be set for a planning period such as the financial year, and actual results should be compared against the planning targets.

Short-term performance

Short-term performance should be monitored by means of operational performance measures. For example, quality might be measured by the percentage of rejected units in production, or the rate of customer returns or customer complaints. Speed might be measured by the average time required to meet a customer order.

1.4 Financial and non-financial performance measures

Performance measures can be financial or non-financial. Accountants tend to think about the performance of a business in financial terms, such as sales, costs and profits. Traditionally, performance reporting by management accountants was restricted to financial performance measures, or 'financial performance indicators' (FPIs).

However, the performance of a business in both the short term and the longer term depends on factors other than financial results. Profits are earned by delivering products or services to customers that customers want to buy, and by operating in an efficient and effective manner. Non-financial aspects of performance are the main reason why a business is financially successful (or performs badly in financial terms) and profits follow on from 'getting the business right'.

It is therefore recognised that non-financial aspects of performance are important and that these should also be measured and monitored (using non-financial performance indicators or NFPIs).

In many organisations, management accountants have taken on responsibility for measuring and reporting non-financial performance, as well as financial performance. There is no obvious reason why management accountants should do this (because they are not 'experts' in non-financial aspects of operations) except that performance reporting should be an integrated management information system. Management accountants are best placed within an entity to report on financial performance. Since they report on financial performance, it is sensible to make them responsible for reporting on aspects of non-financial performance too.

1.5 Performance measurement and the F5 examination

Previous chapters have already explained variance analysis and the assessment of performance using standard costs, budgetary control and variances.

You may also be required to calculate and comment on a number of financial and non-financial performance ratios, which will be described in later sections of this chapter. Before studying ratios in any detail, however, it is important to understand how you might be expected to use ratios in the examination. The F5 examiner has given some guidelines (Student Accountant, May 2008).

- A question may involve a 'case study' and provide information from which you will be required to calculate one or more ratios. The question may indicate which ratios to calculate. On the other hand you may be asked simply to comment on performance, and identify one or more ratios that you consider important or significant. These may be financial or non-financial ratios, or a combination of both.
- Calculating a ratio will not be good enough on its own to earn a pass mark. You will also be required to provide some comments about performance, based on the ratio or ratios that you have calculated. To help with the assessment of performance, the question may provide some background information that you should use. Make use of this background information. It may indicate reasons why performance has been better or worse than expected, or may provide information that enables you to decide whether performance has been 'good' or 'bad'.
- You will be expected to 'hypothesise' and explain why performance has been better or worse than expected, and you are encouraged to express an opinion. Your opinion should be sensible and demonstrate 'business common sense'. The F5 examiner commented (in the article referred to) that 'Candidate must be brave and commit themselves. You must express an opinion. It is not acceptable to suggest that management investigate. Although in the real world this may well happen, in the exam hall you have to demonstrate that you know where to look.'

1.6 Benchmarking

It may be useful to be aware of benchmarking as a method of assessing performance. Benchmarking involves comparing performance with the performance of another, similar organisation or operation. In other words, another organisation or department is used as a 'benchmark for comparison'.

Performance can be assessed in terms of whether it has been better or worse than the selected benchmark. By making such comparisons, it should be possible to identify strengths and weaknesses in performance.

There are three main types of benchmarking.

- **Internal benchmarking**. An entity may have many similar operations, such as regional or area branches. For example, a bank may have a network of branches, and a retail company may have a network of retail stores. The best-performing branches or departments can be used as a benchmark, and the performance of other branches compared against it.
- **Competitive benchmarking**. This involves comparing the performance of the organisation against the performance of its most successful competitors. In this way, the areas of performance where the competitor is better can be identified, and measures can then be planned for reducing the gap in performance.

  The practical difficulty with competitive benchmarking is that the competitor will not willingly act as a benchmark, and allow its competitors to make a detailed study of its operations. Competitive benchmarking is therefore usually done without the competitor's knowledge. For example, a company might buy a product of a successful competitor and analyse its qualities and features in detail, perhaps by taking it apart in a laboratory and investigating its structure and components.
- **Operational benchmarking**. A company might use benchmarking to assess the performance of a particular aspect of its operations, such as customer order handling, handling e-commerce orders from the Internet, or warehousing and despatch operations. It might be able to identify a company in a completely different industry that carries out similar operations successfully. The other company might be prepared to act as a benchmark, and allow its operations to be studied and its staff interviewed. The benefit of this type of benchmarking is that a business is able to learn from world-class companies how to improve its operations and raise its performance levels.

Financial performance indicators (FPIs)

2 Financial performance indicators (FPIs)

2.1 Aspects of financial performance

A common method of analysing and measuring the financial performance of an organisation is by means of ratio analysis. Although profitability is a very important aspect of business performance, it is not the only aspect of financial performance that should be monitored. The main aspects of financial performance are usually:

- profitability
- liquidity
- financial risk.

Information for measuring financial performance is obtained largely from internal sources – financial statements produced by the entity and its accounting systems.

Each financial ratio should be a potential significance. Remember that it is not good enough simply to know how to calculate a ratio. You need to understand what the ratio might tell you about financial performance.

2.2 Using ratios: comparisons

Financial ratios can be used to make comparisons:

- Comparisons over a number of years. By looking at the ratios of a business entity over a number of years, it might be possible to detect improvements or a deterioration in the financial performance or financial position. For example, changes over time can be used to measure rates of growth or decline in sales or profits. Ratios can therefore be used to make comparisons over time, to identify changes or trends, and (perhaps) to assess whether the rate of change is 'good' or 'bad'.
- Comparisons with the similar ratios of other, similar companies for the same period.
- In some cases, perhaps, comparisons with 'industry average' ratios.

2.3 FPIs for measuring profitability

Profitability depends on sales revenues and costs. Financial performance indicators that may be relevant for assessing performance therefore include ratios for sales and costs, as well as profit.

Profitability may also be assessed by relating profit to the amount of capital employed by the business. Return on investment (ROI) and other similar financial ratios are explained in the next chapter.

Percentage annual growth in sales

Business entities will monitor their annual growth (or decline) in sales, measured as a percentage of sales in the previous year.

For example, if sales in the year just ended were $5,800,000 and sales in the previous year were $5,500,000, the annual growth in sales has been ($300,000/$5,500,000) × 100% = 5.45%.

Sales growth can be a very important measure of financial performance for a number of reasons.

- If a company wishes to increase its annual profits, it will probably want to increase its annual sales revenue. Sales growth is usually necessary for achieving a sustained growth in profits over time.
- The rate of growth can be significant. For example, suppose that the annual rate of growth in a particular market is 7%. If a company achieves sales growth in the year of 15%, it will probably consider this to be a good performance. If sales growth is 3%, this would probably be considered poor performance – although sales have increased, they have not increased in line with growth in the market.
- The period of time over which growth is achieved can also be important. For example, if a company achieves growth in sales of 20% during one year, this might be considered a good performance. However, performance would be even better if the company achieves annual growth in sales of 20% over a five-year period. Sustained growth would indicate that performance has been improving over the long term, and might therefore be expected to continue in the future.

Sales growth (or a decline in sales) can usually be attributed to two causes:

- sales prices and
- sales volume.

Any growth in sales should be analysed to identify whether it has been caused by changes in sales prices, changes in sales volume or a combination of both.

(Note: In some cases, a company may introduce new products, or cease producing some of its products); in such cases, growth or decline in sales will also be attributable to changes in the number of products sold.)

Example

Laffco sells orange juice in standard-sized cartons. The market for orange juice is very competitive and there are several larger competitors in the market. Sales data for the previous three years are as follows.

	Current year (just ended)	**Year – 1 (previous year)**	**Year – 2**
Sales revenue	$15 million	$13.5 million	$12 million
Cartons sold (millions)	6 million	5 million	4 million

Required: Analyse sales performance.

Answer

Sales growth in the current year was $(15 million – 13.5 million)/$13.5 million = 11.1%.

Sales growth in the previous year was $(13.5 million – 12 million)/$12 million = 12.5%.

The growth ratios are easy to calculate, but how should they be interpreted?

- In a competitive market, achieving growth in revenue of 12.5% in one year followed by 11.1% the next should probably be considered very good performance.
- The average sales price per carton was $3 two years ago, $2.70 one year ago and $2.50 in the current year. This may suggest that sales growth has been achieved by cutting the sales price: lower sales prices often result in a higher volume of sales.
- The volume of sales (cartons sold) rose by 25% two years ago and 20% in the current year. This strong growth in sales may be due to excellent marketing activity by the company, or to the reductions in the selling price.

On the basis of the limited information available, it seems possible that the company has succeeded in increasing sales within a competitive market by reducing its selling prices.

Profit margin

Profit margin is the profit as a percentage of sales revenue. It is therefore the ratio of the profit that has been achieved for every $1 of sales.

Profit margin = Profit/sales × 100%

It is wrong to conclude, without further analysis, that a high profit margin means 'good performance' and a low profit margin means 'bad performance'. To assess performance by looking at profit margins, it is necessary to look at the circumstances in which the profit margin has been achieved.

- Some companies operate in an industry or market where profit margins are high, although sales volume may be low. Other companies may operate in a market where profit margins are low but sales volumes are much higher. For example, the profit margin earned on high-fashion clothes should be much higher than the profit margin on low-priced clothing sold in large supermarkets or stores.
- Changes in the profit margin from one year to the next should be monitored Improvements may be a sign of 'good performance' and falling profit margins may be a cause for concern.

There are several ways of measuring profit margin. If you are required to measure profit margin in your examination, the most suitable ratio is likely to be:

- Gross profit margin (= gross profit/sales). Gross profit is sales revenue minus the cost of sales.
- Net profit margin (= net profit/sales). Net profit = gross profit minus all other costs, such as administration costs and selling and distribution costs.

Any change in profit margin from one year to the next will be caused by:

- changes in selling prices, or
- changes in costs as a percentage of sales, or
- a combination of both.

Changes in costs as a percentage of sales may be caused by a growth or fall in sales volumes, where there are fixed costs in the entity's cost structure.

Example

Sobco makes and sells footwear. Its profits and sales revenue for the past three years are as follows

	Current year (just ended)	Year – 1 (previous year)	Year – 2
Sales revenue	\$20 million	\$22 million	\$24 million
Items sold	1 million	1.1 million	1.2 million
Gross profit	\$5.8 million	\$6.6million	\$6.8 million
Net profit	\$0.4 million	\$1.2 million	\$1.4 million

Required: Analyse profitability and costs.

Answer

Profit margins are as follows:

	Current year (just ended)	Year – 1 (previous year)	Year – 2
Gross profit margin (%)	29.0%	30.0%	28.3%
Net profit margin (%)	2.0%	5.5%	5.8%

The gross profit margin has fallen slightly in the current year, but is higher than the gross profit margin two years ago. There is insufficient information to assess performance, except to conclude that the gross profit margin has been fairly stable over the three-year period.

(This means that the ratio of cost of sales as a percentage of sales has also been fairly constant. The cost of sales/sales ratio is simply 100% minus the gross profit margin.)

The net profit margin has fallen from 5.8% two years ago to 2.0% in the current year. The actual net profit has fallen from $1.4 million to $0.4 million. The reason for the fall in net profit margin is attributable to either changes in selling prices or changes in costs (as a percentage of sales).

- The average selling price per unit has been $20 in each of the three years, suggesting that the fall in net profit margin is not caused by changes in selling prices.
- The fall in net profit margin is therefore due to changes in costs. Although there has been some variability in the ratio of cost of sales to sales revenue, the main problem appears to be changes in 'other costs' as a percentage of sales.
- Other costs = the difference between gross profit and net profit. Two years ago these were $5.4 million (= $6.8 million - $1.4 million), one year ago they were $5.4 million (= $6.6 million - $1.2 million) and in the current year they were also $5.4 million (= $5.8 million - $0.4 million). This suggests that other costs are all fixed costs.
- Fixed costs have remained constant each year, but sales revenue has fallen due to falling sales volume. The reduction in the net profit margin can therefore be attributed mainly to the higher ratio of other fixed costs to sales revenue – in other words, to falling sales.

Cost/sales ratios

Profitability may also be measured by cost/sales ratios, such as:

- Ratio of cost of sales/sales
- Ratio of administration costs/sales
- Ratio of sales and distribution costs/sales
- Ratio of total labour costs/sales.

Performance may be assessed by looking at changes in these ratios over time. A large increase or reduction in any of these ratios would have a significant effect on profit margin.

2.4 FPIs for measuring liquidity

Liquidity for a business entity means having enough cash, or having ready access to additional cash, to meet liabilities when they fall due for payment. The most important sources of liquidity for non-bank companies are:

- operational cash flows (cash from sales)

- liquid investments, such as cash held on deposit or readily-marketable shares in other companies
- a bank overdraft arrangement or a similar readily-available borrowing facility from a bank.

Cash may also come from other sources, such as the sale of a valuable non-current asset (such as land and buildings), although obtaining cash from these sources may need some time.

Liquidity is important for a business entity because without it, the entity may become insolvent even though it is operating at a profit. If the entity is unable to settle its liabilities when they fall due, there is a risk that a creditor will take legal action and this action could lead on to insolvency proceedings.

In December 2008 a long-established retail company, Woolworths, became insolvent. Although the company was operating at a loss, a major factor in the collapse was lack of sufficient cash to pay for leases on premises that fell due for payment in the month, and which the company did not have the cash to pay.

On the other hand a business entity may have too much liquidity, when it is holding much more cash than it needs, so that the cash is 'idle', earning little or no interest. Managing liquidity is often a matter of ensuring that there is sufficient liquidity, but without having too much.

Changes in the cash balance or bank overdraft balance

A simple method of monitoring liquidity is to keep the cash balance at the bank under continual review, and look for any deterioration (or improvement) in the cash position. If the entity has a bank overdraft facility, the cash position should be monitored to makes sure that the overdraft does not get too close to the limit.

When there is a big change in the cash position, it is important to investigate its cause and judge whether liquidity has become a matter for concern. If you are familiar with statements of cash flows, you should be aware of the various sources of cash and reasons for payments of cash. A large fall in cash (or a big increase in the bank overdraft) may be caused by:

- Operating losses
- Increases in working capital (inventory plus receivables, minus trade payables)
- Expenditures on investments, such as purchases of new non-current assets
- Repayments of debt capital (bank loans) or payments of dividends.

A reduction in cash caused by operating losses would be the most serious reason for a loss of liquidity, but when a business entity is short of liquidity anything that uses up cash may be significant.

Liquidity ratios

Liquidity may also be monitored by looking at changes in a liquidity ratio over time. There are two ratios for measuring liquidity that could be used:

- current ratio
- quick ratio, also called the acid test ratio.

The more suitable ratio for use depends on whether inventory is considered a liquid asset that will soon be used or sold, and converted into cash from sales.

The **current ratio** is the ratio of current assets to current liabilities.

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

It is sometimes suggested that there is an 'ideal' current ratio of 2.0 times (2:1). However, this is not necessarily true and in some industries, much lower current ratios are normal. It is important to assess a current ratio by considering:

- changes in the ratio over time
- the liquidity ratios of other companies in the same industry.

The **quick ratio or acid test ratio** is the ratio of 'current assets excluding inventory' to current liabilities. Inventory is excluded from current assets on the assumption that it is not a very liquid item.

$$\text{Quick ratio} = \frac{\text{Current assets excluding inventory}}{\text{Current liabilities}}$$

This ratio is a better measurement of liquidity than the current ratio when inventory turnover times are very slow, and inventory is not a liquid asset.

It is sometimes suggested that there is an 'ideal' quick ratio of 1.0 times (1:1). However, this is not necessarily true and in some industries, much lower quick ratios are normal. As indicated earlier, it is important to assess liquidity by looking at changes in the ratio over time, and comparisons with other companies and the industry norm.

When there is a significant change in liquidity, the reason should be investigated. Liquidity ratios will deteriorate (i.e. get smaller) when:

- there is an increase in current liabilities without an increase in current assets
- there is a reduction in current assets without a reduction in current liabilities (for example, writing off inventory or bad debts).

Examples of reasons for a reduction in liquidity are:

- operating losses
- using cash to purchase new non-current assets.

2.5 FPIs for measuring financial risk

Financial risk is the risk to a business entity that arises for reasons related to its financial structure or financial arrangements. There are several major sources of financial risk, such as credit risk (= the risk of bad debts because customers who are given credit will fail to pay what they owe) and foreign exchange for companies that import or export goods or services (= the risk of an adverse movement in an important currency exchange rate).

For the purpose of the F5 examination, however, the most significant financial risk is the risk that could arise through borrowing. If an entity borrows money, it will have to pay the money back at some time, and will also have to pay interest. The risk is that if an entity borrows very large amounts of money, it might fail to generate enough cash from its business operations to pay the interest or repay the debt principal.

e

Example

Zapco is an advertising agency. Next year it expects to make a profit before interest of $300,000. The company has a bank loan of $3 million, which is repayable in one year's time and on which the rate of interest is 8%.

What are the financial risks for Zapco?

a

Answer

The annual cost of interest on the bank loan is $240,000 (= 8% × $3,000,000). The profit is enough to cover the interest, but with only $60,000 to spare.

- A financial risk for Zapco is that if profit next year is more than $60,000 below expectation, it will make a loss after interest.
- Another risk is that it may be unable to meet the interest payments on the loan, unless it has spare cash that it can use or other sources of liquidity such as extra bank borrowing.
- A third risk is that when the bank loan has to be repaid in one year's time, Zapco may need to borrow more money in order to repay the loan. This is often referred to as 'renewing' a loan. However the bank might refuse to re-lend the money and might insist on repayment in full and on time. If Zapco can't do this, it will be faced with the risk of insolvency.

Financial risk depends to a large extent on conditions in the financial markets. There have been times when 'credit' has been easy to obtain, and a company wishing to borrow more money could do so quite easily. However, a 'credit bubble' can turn into a 'credit squeeze', when banks cut their lending and are reluctant to renew loans. A global credit squeeze began in 2007, and for many companies with large amounts of borrowing, the risks of insolvency became much greater.

Debt ratios

Debt ratios can be used to assess whether the total debts of the entity are within control and are not excessive.

Gearing ratio (leverage)

Gearing, also called leverage, measures the total long-term debt of a company as a percentage of either:

- the equity capital in the company, or
- the total capital of the company.

$$\text{Gearing} = \frac{\text{Long-term debt}}{\text{Share capital and reserves}} \times 100\%$$

Alternatively:

$$\text{Gearing} = \frac{\text{Long-term debt}}{\text{Share capital and reserves} + \text{Long-term debt}} \times 100\%$$

When there are preference shares, it is usual to include the preference shares within long-term debt, not share capital.

A company is said to be **high-geared** or **highly-leveraged** when its debt capital exceeds its share capital and reserves. This means that a company is high-geared when the gearing ratio is above either 50% or 100%, depending on which method is used to calculate the ratio.

A company is said to be **low-geared** when the amount of its debt capital is less than its share capital and reserves. This means that a company is low-geared when the gearing ratio is less than either 50% or 100%, depending on which method is used to calculate the ratio.

The gearing ratio can be used to monitor changes in the amount of debt of a company over time. It can also be used to make comparisons with the gearing levels of other, similar companies, to judge whether the company has too much debt, or perhaps too little, in its capital structure.

Interest cover ratio

Interest cover measures the ability of the company to meet its obligations to pay interest.

$$\text{Interest cover} = \frac{\text{Profit before interest and tax}}{\text{Interest charges in the year}}$$

An interest cover ratio of less than 3.0 times is considered very low, suggesting that the company could be at risk from too much debt in relation to the amount of profits it is earning.

The risk is that a significant fall in profitability could mean that profits are insufficient to cover interest charges, and the entity will therefore be at risk from any legal action or other action that lenders might take.

2.6 The limitations of financial ratios

There are several limitations or weaknesses in the use of financial ratios for analysing the performance of companies.

- Financial statements are published infrequently. If ratios are used to study trends and developments over time, they are only useful for trends or changes over one year or longer, and not changes in the short-term.
- Ratios can only indicate **possible** strengths or weaknesses in financial position and financial performance. They might raise questions about performance, but do not provide answers. They are not easy to interpret, and changes in financial ratios over time might not be easy to explain.
- Using financial ratios to measure performance can lead managers to focus on the short-term rather than the long-term success of the business.
- There is some risk that managers may decide to 'manipulate' financial performance, for example by delaying a large item of expenditure or bringing forward the date of a major business transaction, in order to increase or reduce profitability in one period (and so reduce or increase the profit for the next financial period). The risk of manipulating financial results is particularly significant when managers are paid annual bonuses on the basis of financial performance.

Non-financial aspects of performance should also be assessed, because:

- as suggested earlier, non-financial aspects of performance determine the size of profits that a company will make in the longer-term
- therefore targets should be established for non-financial aspects of performance, and performance should be measured against those targets.

Non-financial performance indicators (NFPIs)

- Difficulties of target setting for non-financial aspects of performance
- Analysing non-financial performance
- NFPIs in service industries

3 Non-financial performance indicators (NFPIs)

3.1 Difficulties of target setting for non-financial aspects of performance

There are several difficulties with measuring and assessing performance using NFPIs.

Selecting the key performance indicators

Non-financial performance refers to every aspect of operations within a business except the financial aspect, and performance targets can be set for every department throughout the entity.

Here are just several non-financial performance indicators that might be used in a reporting system:

- Product quality or quality of service
- Speed of order processing or speed of any other processing cycle
- Customer satisfaction
- Brand awareness amongst target customers
- Labour turnover rate
- Number of man-days of training provided for employees
- Amount of down-time with IT systems
- Number of suppliers identified for key raw material supplies
- Length of delays on completion of projects
- Capacity utilised (as a percentage of 100% capacity).

For the purpose of assessing the performance of the entity as a whole, however, it is necessary to identify which aspects of non-financial performance are the most important. The problem is to decide which aspects of performance are critically important. A number of frameworks or models for selecting key non-financial performance indicators have been suggested. These include:

- the balanced scorecard
- the performance pyramid
- the building block model of Fitzgerald and Moon.

These models are described later.

Variability in the circumstances of different businesses

With financial performance measurement, there are a limited number of financial ratios that are used, which can be applied to all types of business.

With NFPIs, the key measures of performance vary between different types of business, and depend on the nature of the business. For example, the key non-financial measures of performance for a chemical manufacturer will differ from those of a passenger transport company such as a bus or train company.

Time scale for achievement

Financial performance targets are often set for a budget period, and actual performance is compared against budget. Non-financial performance targets need not be restricted to one year, and in some cases it may be sensible to establish targets for a longer term (or possibly a shorter term) than one year.

Unfortunately, if some employees are awarded cash bonuses for achieving non-financial performance targets, there will be a tendency to set annual targets in order to fit in with the annual budget cycle.

Setting targets for quality

The quality of a product or service may be a key aspect of non-financial performance. However, it can be very difficult to define what is meant by 'quality'. For example, quality could refer to:

- Features of a product design or aspects of a service
- The number of mistakes that are made in a process
- The number of rejected items in quality inspection
- Value for money.

There are different aspects of quality, but for the purpose of performance measurement it is necessary to identify which are the critical or key aspects of quality, and set quality performance targets accordingly.

3.2 Analysing NFPIs

You need to remember the guidance from the F5 examiner about measuring and assessing performance. The same guidance applies to non-financial performance as to financial performance.

- It is not sufficient simply to calculate a performance ratio or other performance measurement.
- You need to explain the significance of the ratio – What does it mean? Does it indicate good or bad performance, and why?
- Look at the background information given in the exam question and try to identify a possible cause or reason for the good or bad performance.
- Possibly, think of a suggestion for improving performance. What might be done by management to make performance better?

3.3 NFPIs in service industries

Management accounting has its origins in manufacturing and construction industries. Over time, service industries have become a much more significant aspect of business, especially in countries with developed economies.

Performance measures – both financial and non-financial – are needed for service industries, but the key measures that are best suited to service industries are often very different from the key NFPIs in manufacturing.

Even some of the key financial performance measures in service industries may be a combination of both financial and non-financial performance, such as:

- Annual sales revenue per cubic metre of shelf space (ratio used by supermarkets and other stores)
- Cost per tonne-mile carried (road haulage companies)
- Cost per passenger-mile carried (transport companies)
- Average income per consultant day (management consultancy company).

The balanced scorecard approach

- The concept of the balanced scorecard
- The balanced scorecard: four perspectives of performance
- Using the balanced scorecard
- Conflicting targets for the four perspectives

4 The balanced scorecard approach

4.1 The concept of the balanced scorecard

The balanced scorecard approach was developed by Kaplan and Norton in the 1990s as an approach to measuring performance in relation to long-term objectives. They argued that for a business entity, the most important objective is a financial objective. However, in order to achieve financial objectives over the long term, it is also necessary to achieve goals or targets that are non-financial in nature, as well as financial.

The concept of the balanced scorecard is that there are several aspects of performance ('perspectives on performance') and targets should be set for each of them. The different #perspectives' may sometimes appear to be in conflict with each other, because achieving an objective for one aspect of performance could mean having to make a compromise with other aspects of performance. The aim should be to achieve a satisfactory balance between the targets for each of the different perspectives on performance. These targets, taken together, provide a balanced scorecard, and actual performance should be measured against all the targets in the scorecard.

The reason for having a balanced scorecard is that by setting targets for several key factors, and making compromises between the conflicting demands of each factor, managers will take a more balanced and long-term view about what they should be trying to achieve. A balanced scorecard approach should remove the emphasis on financial targets and short-term results.

However, although a balanced scorecard approach takes a longer-term view of performance, it is possible to set shorter-term targets for each item on the scorecard. In this way it is possible to combine a balanced scorecard approach to measuring performance with the annual budget cycle, and any annual incentive scheme that the entity may operate.

4.2 The balanced scorecard: four perspectives of performance

In a balanced scorecard, critical success factors are identified for four aspects of performance, or four 'perspectives':

- customer perspective
- internal perspective

- innovation and learning perspective
- financial perspective.

Of these four perspectives, three are non-financial in nature.

For each perspective, Kaplan and Norton argued that an entity should identify key performance measures and key performance targets. The four perspectives provide a framework for identifying what those measures should be, although the specific measures used by each entity will vary according to the nature of the entity's business.

For each perspective, the key performance measures should be identified by answering a key question. The answer to the question indicates what are the most important issues. Having identified the key issues, performance measures can then be selected, and targets set for each of them.

Perspective	The key question
Customer perspective	**What do customers value?** By recognising what customers value most, the entity can focus its performance targets on satisfying the customer more effectively. Targets might be developed for several aspects of performance such as cost (value for money), quality or place of delivery.
Internal perspective	**To achieve its financial and customer objectives, what processes must the organisation perform with excellence?** Management should identify the key aspects of operational performance and seek to achieve or maintain excellence in this area. For example, an entity may consider that customers value the quality of its service, and that a key aspect of providing a quality service is the effectiveness of its operational controls in preventing errors from happening.
Innovation and learning perspective	**How can the organisation continue to improve and create value?** The focus here is on the ability of the organisation to maintain its competitive position, through the skills and knowledge of its work force and through developing new products and services, or making use of new technology as it develops.
Financial perspective	**How does the organisation create value for its owners?** Financial measures of performance in a balanced scorecard system might include share price growth, profitability and return on investment.

Several measures of performance may be selected for each perspective, or just one. Using a large number of different measures for each perspective adds to the complexity of the performance measurement system.

4.3 Using the balanced scorecard

With the balanced scorecard approach the focus should be on strategic objectives and the critical success factors necessary for achieving them. The main focus is on what needs to be done now to ensure continued success in the future.

The main performance report for management each month is a balanced scorecard report, not budgetary control reports and variance reports.

Examples of measures of performance for each of the four perspectives are as follows. This list is illustrative only, and entities may use different measurements.:

Perspective	Outcome measures
Critical financial measures	Return on investment Profitability and profitability growth Revenue growth Productivity and cost control Cash flow and adequate liquidity Avoiding financial risk: limits to borrowing
Critical customer measures	Market share and market share growth Customer profitability: profit targets for each category of customer Attracting new customers: number of new customers or percentage of total annual revenue obtained from new customers during the year Retaining existing customers Customer satisfaction, although measurements of customer satisfaction may be difficult to obtain On-time delivery for customer orders
Critical internal measures	Success rate in winning contract orders Effectiveness of operational controls, measured by the number of control failures identified during the period Production cycle time/throughput time Amount of re-working of defective units
Critical innovation and learning measures	Revenue per employee Employee productivity Employee satisfaction Employee retention or turnover rates Percentage of total revenue earned from sales of new products Time to develop new products from design to completion of development and introduction to the market

Example: balanced scorecard

Kaplan and Norton described the example of Mobil in the early 1990s, in their book *The Strategy-focussed Organisation*. Mobil, a major supplier of petrol, was competing with other suppliers on the basis of price and the location of petrol stations. Its strategic focus was on cost reduction and productivity, but its return on capital was low.

The company's management re-assessed their strategy, with the aim of increasing market share and obtaining stronger brand recognition of the Mobil brand name. They decided that the company needed to attract high-spending customers who would buy other goods from the petrol station stores, in addition to petrol.

As its high-level financial objective, the company set a target of increasing return on capital employed from its current level of about 6% to 12% within three years.

- From a **financial perspective**, it identified such key success factors as productivity and sales growth. Targets were set for productivity (reducing operating costs per gallon of petrol sold) and 'asset intensity' (ratio of operational cash flow to assets employed).
- From a **customer perspective**, Mobil carried out market research into who its customers were and what factors influenced their buying decisions. Targets were set for providing petrol to customers in a way that would satisfy the customer and differentiate Mobil's products from rival petrol suppliers. Key issues were found to be having petrol stations that were clean and safe, and offering a good quality branded product and a trusted brand. Targets were set for cleanliness and safety, speedy service at petrol stations, helpful customer service and rewarding customer loyalty.
- From an **internal perspective**, Mobil set targets for improving the delivery of its products and services to customers, and making sure that customers could always buy the petrol and other products that they wanted, whenever they visited a Mobil station.

4.4 Conflicting targets for the four perspectives

A criticism that has been made against the balanced scorecard approach is that the targets for each of the four perspectives might often conflict with each other. When this happens, there might be disagreement about what the priorities should be.

This problem should not be serious, however, if it is remembered that the financial is the most important of the four perspectives for a commercial business entity. The term 'balanced' scorecard indicates that some compromises have to be made between the different perspectives.

A useful sporting analogy was provided in an article in *Financial Management* magazine (Gering and Mntambo, November 2001). They compared the balanced scorecard to the judgements of a football team manager during a football match. The objective is to win the match and the key performance measure is the score.

However, as the match progresses, the manager will look at other important aspects of performance, such as the number of shots at the goal by each side, the number of corner kicks, the number of tackles and the percentage of possession of the ball enjoyed by the team.

Shots on goal corner kicks, tackles and possession of the ball are all necessary factors in scoring goals, not conceding goals, and winning the match. The manager will therefore use them as indicators of how well or badly the match is progressing. However, the score is ultimately the only thing that matters.

In the same way, targets for four perspectives are useful in helping management to judge progress towards the company's objectives, but ultimately, success in achieving those objectives is measured in financial terms. The financial objective is the most important.

The performance pyramid

- The concept of te performance pyramid
- The pyramid structure: linking performance targets throughout an organisation
- Interpreting the performance pyramid

5 The performance pyramid

5.1 The concept of the performance pyramid

The performance pyramid is another approach to creating a structure for a performance measurement system that combines non-financial and financial performance indicators, and which helps to identify key areas of non-financial performance.

The concept of a performance pyramid is based on the idea that an entity operates at different levels and these levels form a hierarchy. The overall objective is at the top of this hierarchy. Each level has different concerns and different performance targets are appropriate for each level. However, performance objectives at a lower level should support the performance objectives at a higher level. Taken together all the performance objectives taken together support the overall objective of the business as a whole.

Performance can therefore be seen as a pyramid structure, with a large number of operational performance targets supporting higher-level targets, leading to targets for the achievement of overall corporate objectives at the top.

5.2 The pyramid structure: linking performance targets throughout an organisation

The performance pyramid model was developed by Lynch and Cross (1991. They argued that traditional performance measurement systems were not as effective as they should be, because they had a narrow financial focus – concentrating on measures such as return on capital employed, profitability, cash flow and so on. They argued that in a dynamic business environment, achieving strategic business objectives depends on good performance with regard to non-financial aspects of performance, and in particular:

- **Customer satisfaction**. This is a 'marketing' objective: here, the focus is on external/market effectiveness
- **Flexibility**. The flexibility objective relates to both external effectiveness and internal efficiency with in the organisation: an entity needs to respond to developments and changes in circumstances when they occur.
- **Productivity**: resource utilisation. Here, the focus is on internal efficiency, much of which can be measured by financial performance and financial ratios or variances)

These key 'driving forces' can be monitored at the operational level with performance measures relating to:

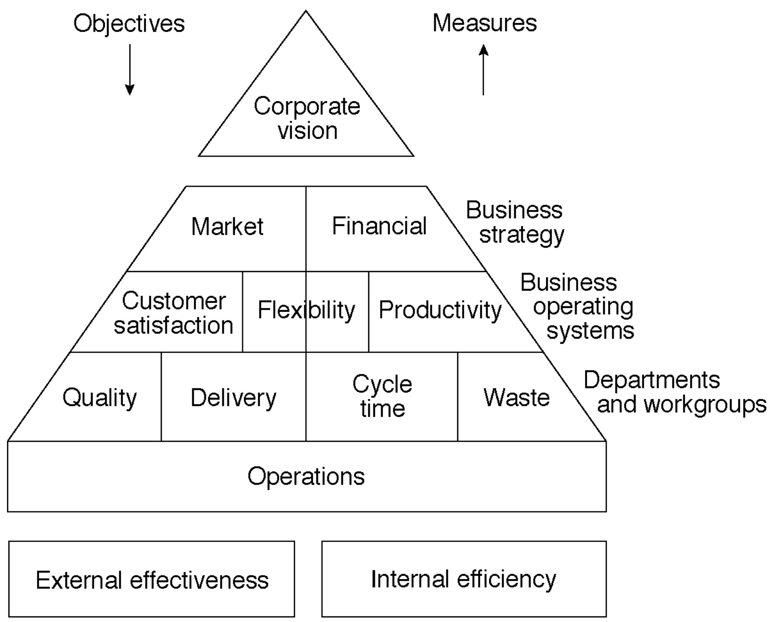
- quality
- delivery
- cycle time (e.g. the length of the production cycle, or the length of the customer order handling cycle) and
- waste.

Lynch and Cross argued that within an organisation, there are different levels of management and each has its own focus. However, there must be consistency between performance measurement at each management level, so that performance measures at the operational level support the corporate strategy.

They presented these ideas in the form of a pyramid of targets and performance that links operations to corporate strategy.

A performance pyramid can be presented as follows:

Performance pyramid



5.3 Interpreting the performance pyramid

The performance pyramid links strategic objectives with operational targets, internally-focused objectives with externally-focused objectives, and financial and non-financial objectives.

- Objectives and targets are set from the top level (corporate vision) down to the operational level. Performance is measured from an operational level upwards. If performance targets are achieved at the operational level, targets should be achieved at the operating systems level. Achieving targets for operating systems should help to ensure the achievement of marketing and financial strategy objectives, which in turn should enable the organisation to achieve its corporate objectives.

- A key level of performance measurement is at the operating systems level – achieving targets for customer satisfaction, flexibility and productivity. To achieve performance targets at this level, operational targets must be achieved - for quality, delivery, cycle time and waste.
- With the exception of flexibility, which has both an internal and an external aspect, performance measures within the pyramid (and below the corporate vision level) can be divided between:
  - market measures, or measures of external effectiveness, and
  - financial measures, or measures of internal efficiency.
- The measures of performance are inter-related, both at the same level within the pyramid and vertically, between different levels in the pyramid. For example:
  - New product development is a business operating system. When a new product is introduced to the market, success depends on meeting customer needs (customer satisfaction), adapting customer attitudes and production systems in order to make the changes (flexibility) and delivering the product to the customer at the lowest cost for the required quality (productivity).
  - Achieving improvements in productivity depends on reducing the cycle time (from order to delivery) or reducing waste.

Lynch and Cross argued that the performance measures that are chosen should link operations to strategic goals.

- All operational departments need to be aware of how they are contributing to the achievement of strategic goals.
- Performance measures should be a combination of financial and non-financial measures that are of practical value to managers. Reliable information about performance should be readily available to managers whenever it is needed.

Performance measurement in service industries: the building block model of Fitzgerald and Moon

- The characteristics of services and service industries
- Performance in service industries: Fitzgerald and Moon
- Dimensionsof performance
- Standards of performance
- Rewards for performance

6 Performance measurement in service industries: the building block model of Fitzgerald and Moon

6.1 The characteristics of services and service industries

Many organisations provide services rather than manufacture products. There are many examples of service industries: hotels, entertainment, the holiday and travel industries, professional services, banking, cleaning services, and so on.

Performance measurement for services may differ from performance measurement in manufacturing in several ways:

- **Simultaneity**. With a service, providing the service ('production') and receiving consumption the service ('consumption' by the customer) happen at the same time. In manufacturing, the making of the product happens before the customer buys it.
- **Perishability**. It is impossible to store a service for future consumption: unlike manufacturing and retailing, there is no inventory of unused services. The service must be provided when the customer wants it.
- **Heterogeneity**. A product can be made to a standard specification. With a service provided by humans, there is variability in the standard of performance. The service is different in some way each time that it is provided. For example, even if they perform the same songs at several concerts, the performance of a rock band at a series of concerts will be different each time.
- **Intangibility**. With a service, there are many intangible elements of service that the customer is given, and that individual customer might value. For example, a high quality of service in a restaurant is often intangible, but noticed and valued by the customer.

Since services differ to some extent from products, should performance setting and performance measurement be different in service companies, compared with manufacturing companies?

6.2 Performance in service industries: Fitzgerald and Moon

Fitzgerald and Moon (1996) suggested that a performance management system in a service organisation can be analysed as a combination of three building blocks:

- dimensions
- standards, and
- rewards.

These are shown in the following diagram, which is known as the 'building block model'.

Building blocks for performance measurement systems
(Fitzgerald and Moon 1996)

<table>
<tr><td colspan="2">Dimensions
Profit
Competitiveness
Quality
Resource utilisation
Flexibility
Innovation</td></tr>
<tr><td>Standards
Ownership
Achievability
Equity</td><td>Rewards
Clarity
Motivation
Controllability</td></tr>
</table>

6.3 Dimensions of performance

Dimensions of performance are the aspects of performance that are measured. To establish a performance measurement system for a service industry, a decision has to be made about the dimensions of performance that should be used for measuring performance.

Research by Fitzgerald and others (1993) and by Fitzgerald and Moon (1996) concluded that there are six aspects to performance measurement that link performance to corporate strategy. These are:

- profit (financial performance)
- competitiveness
- quality
- resource utilisation
- flexibility
- innovation.

Performance measures should be established for each of these six dimensions. Some performance measures that might be used for each dimension are set out in the following table.

Dimension of performance	Possible measure of performance
Financial performance	Profitability Growth in profits Profit margin Note: Return on capital employed is possibly not so relevant in a service industry, where the company employs fairly small amounts of capital.
Competitiveness	Growth in sales Retention rate for customers (or percentage of customers who buy regularly: 'repeat sales') Success rate in converting enquiries into sales Market share
Service quality	Number of complaints Whether the rate of complaints is increasing or decreasing Customer satisfaction, as revealed by customer opinion surveys Number of errors discovered
Flexibility	Possibly the mix of different types of work done by employees, to assess the flexibility of the work force Possibly the speed in responding to customer requests, to assess flexibility of response to customers' needs
Resource utilisation	Efficiency/productivity measures, such as material wastage rates, rates of loss in production, labour efficiency Utilisation rates: percentage of available time utilised in 'productive' activities, machine utilsation
Innovation	Number of new services offered Percentage of total sales income that comes from services introduced in the last one or two years

Other measures of performance might be appropriate for each dimension, depending on the nature of the service industry. However, this framework of six dimensions provides a structure for considering what measures of performance might be suitable.

The dimensions of performance should also distinguish between:

- 'results' of actions taken in the past, and
- 'determinants' of future performance.

Some dimensions of performance measure the results of decisions that were taken in the past, that have now had an effect. Fitzgerald and Moon suggested that results of past actions are measured by:

- financial performance and
- competitiveness.

Other dimensions of performance will not have an immediate effect, and do not measure the effects of decisions taken in the past. Instead they measure progress towards achieving strategic objectives in the future. The 'drivers' or 'determinants' of future performance are:

- quality
- flexibility
- resource utilisation
- innovation.

These are dimensions of competitive success now and in the future, and so are appropriate for measuring the performance of current management. Measuring performance in these dimensions 'is an attempt to address the short-termism criticism frequently levelled at financially-focused reports' (Fitzgerald). This is because they recognise that by achieving targets now, future performance will benefit. Improvements in quality, say, might not affect profitability in the current financial period, but if these quality improvements are valued by customers, this will affect profits in the future.

6.4 Standards of performance

The second part of the framework for performance measurement suggested by Fitzgerald and Moon relates to setting expected standards of performance, once the dimensions of performance have been selected. This considers behavioural aspects of performance targets.

There are three aspects to setting standards of performance:

- To what extent do individuals feel that they **own** the standards that will be used to assess their performance? Do they accept the standards as their own, or do they feel that the standard shave been imposed on them by senior management?
- Do the individuals held responsible for achieving the standards of performance consider that these standards are **achievable**, or not?
- Are the standards **fair ('equitable')** for all managers in all business units of the entity?

It is recognised that individuals should 'own' the standards that will be used to assess their performance, and managers are **more likely to own the standards when they have been involved in the process of setting the standards**.

It has also been argued that if an individual accepts or 'owns' the standards of performance, better performance will be achieved when the standard is more demanding and difficult to achieve than when the standard is easy to achieve. This means that the standards of performance that are likely to motivate individuals the most are standards that will not be achieved successfully all the time. Budget targets should therefore be challenging, but not impossible to achieve.

Finding a balance between standards that the company thinks are achievable and standards that the individual thinks are achievable can be a source of conflict between senior management and their subordinates.

6.5 Rewards for performance

The third aspect of the performance measurement framework of Fitzgerald and Moon is rewards. This refers to the structure of the rewards system, and how individuals will be rewarded for the successful achievement of performance targets. This aspect of performance also has behavioural implications.

One of the main roles of a performance measurement system should be to ensure that strategic objectives are achieved successfully, by linking operational performance with strategic objectives.

According to Fitzgerald, there are three aspects to consider in the reward system.

- The system of setting performance targets and rewarding individuals for achieving those targets must be clear to everyone involved. Provided that managers accept their performance targets, **motivation** to achieve the targets will be greater when the targets are **clear** (and when the managers have participated in the target-setting process).
- Employees may be motivated to work harder to achieve performance targets when they are **rewarded for successful achievements**, for example with the payment of an annual bonus.
- Individuals should only be held **responsible for aspects of financial performance that they can control**. This is a basic principle of responsibility accounting. A common problem, however, is that some costs are incurred for the benefit of several divisions or departments of the organisation. The **costs of these shared services** have to be allocated between the divisions or departments that use them. The principle that costs should be controllable therefore means that the allocation of shared costs between divisions must be fair. In practice, arguments between divisional managers often arise because of disagreements as to how the shared costs should be shared.

CHAPTER 13

Divisional performance

Contents

Divisional performance evaluation

- Decentralisation of authority
- Benefits of decentralisation
- Disadvantages of decentralisation
- Controllable profit and traceable profit

1 Divisional performance evaluation

1.1 Decentralisation of authority

Decentralisation involves the delegation of authority within an organisation. Within a large organisation, authority is delegated to the managers of cost centres, revenue centres, profit centres and investment centres.

A divisionalised structure refers to the organisation of an entity in which each operating unit has its own management team which reports to a head office. Divisions are commonly set up to be responsible for specific geographical areas or product lines within a large organisation.

The term 'decentralised divisionalised structure' means an organisation structure in which authority has been delegated to the managers of each division to decide selling prices, choose suppliers, make output decisions, and so on.

1.2 Benefits of decentralisation

Decentralisation should provide several benefits for an organisation.

- Decision-making should improve, because the divisional managers make the tactical and operational decisions, and top management is free to concentrate on strategy and strategic planning.
- Decision-making at a tactical and operational level should improve, because the divisional managers have better 'local' knowledge.
- Decision-making should improve, because decisions will be made faster. Divisional managers can make decisions 'on the spot' without referring them to senior management.
- Managers may be more motivated to perform well if they are empowered to make decisions and rewarded for performing well against fair targets
- Divisions provide useful experience for managers who will one day become top managers in the organisation.
- Within a large multinational group, there can be tax advantages in creating a divisional structure, by locating some divisions in countries where tax advantages or subsidies can be obtained.

1.3 Disadvantages of decentralisation

Decentralisation can lead to problems.

- The divisional managers might put the interests of their division before the interests of the organisation as a whole. Taking decisions that benefit a division might have adverse consequences for the organisation as a whole. When this happens, there is a lack of 'goal congruence'.
- Top management may lose control over the organisation if they allow decentralisation without accountability. It may be necessary to monitor divisional performance closely. The cost of such a monitoring system might be high.
- It is difficult to find a satisfactory measure of historical performance for an investment centre that will motivate divisional managers to take the best decisions. For example, measuring divisional performance by Return on Investment (ROI) might encourage managers to make inappropriate long-term investment decisions. This problem is explained in more detail later.
- Economies of scale might be lost. For example, a company might operate with one finance director. If it divides itself into three investment centres, there might be a need for four finance directors – one at head office and one in each of the investment centres. Similarly there might be a duplication of other systems, such as accounting system and other IT systems.

1.4 Controllable profit and traceable profit

Profit is a key measure of the financial performance of a division. However, in measuring performance, it is desirable to identify:

- costs that are controllable by the manager of the division, and also
- costs that are traceable to the division. These are controllable costs plus other costs directly attributable to the division over which the manager does not have control.

There may also be an allocation of general overheads, such as a share of head office costs.

In a divisionalised system, profit centres and investment centres often trade with each other, buying and selling goods and services. These are internal sales, priced at an internal selling price (a 'transfer price'). Reporting systems should identify external sales of the division and internal sales as two elements of the total revenue of the division. Transfer prices are the subject of the next chapter.

	$
External sales	600,000
Internal sales	150,000
Total sales	750,000
Costs controllable by the divisional manager:	
Variable costs	230,000
Contribution	420,000
Controllable fixed costs	140,000
Profit attributable to the manager (controllable profit)	280,000
Costs traceable to the division but outside the manager's control	160,000
Profit traceable to the division	120,000
Share of general overheads	30,000
Net profit	90,000

Notes

- **Controllable profit** is used to assess the manager and is therefore sometimes called the **managerial evaluation**.
- **Traceable profit** is used to assess the performance of the division and is sometimes called the **economic evaluation**.
- The apportionment of general head office costs should be excluded from the analysis of the manager's performance and the division's performance.

These profit measures can be used with variance analysis, ratio analysis, return on investment, residual income and non-financial performance measurements to evaluate performance.

Return on Investment (ROI)

- The reason for using ROI as a financial performanc eindicator
- Measuring ROI
- ROI and investment decisions
- Advantages and disadvantages of ROI for measuring performance

2 Return on Investment (ROI)

2.1 The reason for using ROI as a financial performance indicator

Return on investment (ROI) is a measure of the return on capital employed for an investment centre. It is also called the accounting rate of return (ARR).

It is often used as a measure of divisional performance for investment centres because:

- the manager of an investment centre is responsible for the profits of the centre and also the assets invested in the centre, and
- ROI is a performance measure that relates profit to the size of the investment.

Profit is not a suitable measure of performance for an investment centre. It does not make the manager accountable for his or her use of the net assets employed (the investment in the investment centre).

Example

A company has two divisions which are treated as investment centres for the purpose of performance reporting. Centre 1 has net assets of $5 million and made a profit of $250,000. Centre 2 has net assets of $1 million and made a profit of $150,000.

If the performance of the centres is compared on the basis of profits, the performance of Centre 1 ($250,000) is better than the performance of Centre 2 ($150,000). However Centre 1 employed assets of $5 million to earn its profit and its ROI was just 5% ($350,000/$5 million). Centre 2 employed assets of just $1 million and its ROI was 15%. Comparing performance on the basis of ROI, Centre 2 performed better.

2.2 Measuring ROI

Performance measurement systems could use ROI to evaluate the performance of both the manager and the division. ROI is the profit of the division as a percentage of capital employed.

$$\text{ROI} = \frac{\text{Profit}}{\text{Capital employed (size of investment)}}$$

ROI can be measured in different ways, but for the F5 examination the recommended measures are as follows:

- **Profit**. This should be the annual accounting profit of the division, without any charge for interest on capital employed. This means that the profit is after deduction of any depreciation charges on non-current assets.
- **Capital employed/investment**.
  - This should be the sum of the non-current assets used by the division plus the working capital that it uses. Working capital = current assets minus current liabilities, which for a division will normally consist of inventory plus trade receivables minus trade payables.
  - An examination question may ignore working capital in the figures that it provides. If so, capital employed will consist of non-current assets only.
  - Non-current assets could be measured at their initial cost. However, it is more usual to measure non-current assets at their carrying value, which in an examination question is likely to be at cost less accumulated depreciation.
  - Capital employed may be the capital employed at the beginning of the financial year, the end of the financial year or the average capital employed for the year. Check an examination question carefully to establish which of these is required.

Example

An investment centre has reported the following results.

	Current year	**Previous year**
	$000	$000
Sales	600	600
Gross profit	180	210
Net profit	24	30
Net assets at beginning of year	200	180

Required: Discuss the financial performance of the investment centre. ROI is measured using net assets at the beginning of the year.

Answer

ROI should be used to measure the performance of the division, but other financial ratios should also be used if appropriate. In this example, sales revenue growth in the current year has been 0% and we can also measure the gross profit margin and net profit margin.

	Current year	Previous year
	$000	$000
Gross profit margin (%)	30%	35%
Net profit margin (%)	4%	5%
ROI (24/200; 30/180)	12%	17%

ROI has fallen from 17% to 12%, which is a large fall. The total investment has increased from $180,000 to $200,000 but there has been no increase in sales revenue in spite of the bigger investment.

A reason for the fall in ROI is the fall in gross profit and the gross profit margin, from 35% to 30%. Other costs have been reduced from $180,000 in the previous year ($210,000 - $30,000) to $156,000 in the current year ($180,000 - $24,000), but in spite of the reduction in these costs, the net profit margin also fell from 5% to 4%.

The failure to achieve any growth in sales (in spite of an increase in investment) and the fall in gross profit margin are the reasons for the deterioration in financial performance, as measured by ROI. This could be caused by intense competition in the market in the current year (resulting in lower prices but no revenue growth), although there is a possibility that the cost of sales are out of control.

2.3 ROI and investment decisions

The performance of the manager of an investment centre may be judged on the basis of ROI – whether the division has succeeded or not in achieving a target ROI for the financial year, or whether ROI has improved since the previous year.

If an incentive scheme is in operation, a divisional manager may receive a bonus on the basis of the ROI achieved by the division.

Investment centre managers may therefore have a strong incentive to improve the ROI of their division, and to avoid anything that will reduce the ROI. This can be a serious problem when investment decisions are involved. When an investment centre manager's performance is evaluated by ROI, the manager will probably be motivated to make investment decisions that increase the division's ROI in the current year, and reject investments that would reduce ROI in the current year.

The problem is that investment decisions are made for the longer term, and a new investment that reduces ROI in the first year may increase ROI in subsequent year. An investment centre manager may therefore reject an investment because of its short-term effect on ROI, without giving proper consideration to the longer term.

Example

A division has net assets of $800,000 and makes an annual profit of $120,000. It should be assumed that if the investment described below is not undertaken, the division will continue to have net assets of $800,000 and an annual profit of $120,000 for the next four years.

The divisional is considering an investment in a new item of equipment that would cost $80,000. The estimated life of the equipment is four years with no residual value. The estimated additional profit before depreciation from the investment is as follows:

Year	$
1	20,000
2	25,000
3	35,000
4	40,000

The asset will be depreciated on a straight-line basis.

Required: What would be the ROI on this investment? ROI should be measured on the basis of the average net assets employed during the year.
Would the investment centre manager decide to undertake this investment or not?

a

Answer

The annual profit from the investment, allowing for depreciation of $20,000 per year, and the annual ROI of the division would be as follows:

Year	Profit without the investment	Extra profit from the investment	Total profit	Net assets	ROI
	$	$	$	$	
1	120,000	00	120,000	870,000	13.8%
2	120,000	5,000	125,000	850,000	14.7%
3	120,000	15,000	135,000	830,000	16.3%
4	120,000	20,000	140,000	810,000	17.3%

Note: Net assets are $800,000 plus the net assets for the new investment. The net asset value of the new investment is $80,000 at the beginning of Year 1, $60,000 at the beginning of Year 2 and so on down to $0 at the end of Year 4. Average net assets are therefore $70,000 in Year 1, $50,000 in Year 2, $30,000 in Year 3 and $10,000 in Year 4.

Without the new investment, the annual ROI would be 15% (= $120,000/$800,000).

The new investment would therefore reduce ROI in the first and second years, and increase ROI in Year 3 and Year 4. It is therefore probable that the divisional manager, if he is more concerned about financial performance in the short term, will decide that the investment should not be undertaken, even though over a four-year period the investment may be worthwhile.

Note. Investment decisions should not be taken on the basis of ROI, even though divisional managers are often tempted to do so. We can, however, calculate the average ROI from this proposed investment:

	$
Total 4-year profits before depreciation	120,000
Depreciation over four years	80,000
Total profit over 4 years	40,000
Average annual profit from the investment	10,000

Average asset carrying value over 4 years: $\frac{80,000+0}{2} = \$40,000$

Average ROI = $10,000/$40,000 = 25%.
This is higher than the ROI of 15% achieved from the division's other assets.

2.4 Advantages and disadvantages of ROI for measuring performance

Advantages of using ROI

There are several advantages in using ROI as a measure of the performance of an investment centre.

- It relates the profit of the division to the capital employed, and the division manager is responsible for both profit and capital employed.
- ROI is a percentage measure and can be used to compare the performance of divisions of different sizes.
- It is an easily understood measure of financial performance.
- It focuses attention on capital as well as profit, and encourages managers to sell off unused assets and avoid excessive working capital (inventory and receivables).

Disadvantages of using ROI

There are also disadvantages in using ROI as a measure of the performance of an investment centre.

- As explained above, investment decisions might be affected by the effect they would have on the division's ROI in the short term, and this is inappropriate for making investment decisions.
- There are different ways of measuring capital employed. ROI might be based on the net book value (carrying value) of the division at the beginning of the year, or at the end of the year, or the average for the year. Comparison of performance between different organisations is therefore difficult.
- When assets are depreciated, ROI will increase each year provided that annual profits are constant. The division's manager might not want to get rid of ageing

assets, because ROI will fall if new (replacement) assets are purchased. This point is explained in a later section of this chapter.

- ROI is an accounting measure of performance. An alternative system of performance measurement that includes non-financial performance indicators, such as a balanced scorecard approach, might be more appropriate.

Residual income (RI)

- Measuring residual income
- Imputed interest (notional interest) and the cost of capital
- Residual income and investment decisions
- Advantages and disadvantages of residual income

3 Residual income (RI)

3.1 Measuring residual income

Residual income (RI) is another way of measuring the performance of an investment centre. It is an alternative to using ROI.

Residual income = Divisional profit minus Imputed interest charge.

Note

Divisional profit is an accounting measurement of profit, after depreciation charges are subtracted. It is the same figure for profit that would be used to measure ROI.

3.2 Imputed interest (notional interest) and the cost of capital

Residual income is calculated by deducting an amount for imputed interest (also called notional interest) from the accounting profit for the division.

The **interest charge** is calculated by applying a cost of capital to the division's net investment (net assets). The most appropriate measure of net investment is the average investment during the period, although an exam question may instruct you to calculate the interest charge on net assets at the beginning of the year.

Imputed interest (notional interest) is the division's capital employed, multiplied by:

- the organisation's cost of borrowing, or
- the weighted average cost of capital of the organisation, or
- a special risk-weighted cost of capital to allow for the special business risk characteristics of the division. A higher interest rate would be applied to divisions with higher business risk.

Example

The same example that was used in the previous section to illustrate ROI will be used here to illustrate residual income.

An investment centre has reported the following results.

	Current year	Previous year
	$000	$000
Sales	600	600
Gross profit	180	210
Net profit	24	30
Net assets at beginning of year	200	180

The division has a cost of capital of 10%, which is applied to net assets at the beginning of the year to calculate notional interest.

Required: How would the financial performance of the investment centre be assessed if residual income is used as the main measure of performance?

a

Answer

The residual income of the division in each year is calculated as follows.

	Current year		Previous year	
		$000		$000
Profit		24,000		30,000
Notional interest	(10% × $200,000)	(20,000)	(10% × $180,000)	(18,000)
Residual income		4,000		12,000

Residual income has fallen from $12,000 in the previous year to $4,000 in the current year. This indicates deterioration in divisional performance, although the residual income is still positive. This means that the division's profits exceed its cost of capital.

An analysis of gross profit margin, net profit margin and sales growth (0%) will indicate the causes of the fall in residual income.

3.3 Residual income and investment decisions

One reason for using residual income instead of ROI to measure a division's financial performance is that residual income has a money value, whereas ROI is a percentage value. A company may prefer to measure performance in money terms. In most other respects, however, residual income is similar to ROI as a measure of divisional performance.

e

Example

The difference between ROI and residual income can be illustrated by returning to the previous example that was used to illustrate the effect of ROI on investment decision-making.

A division has net assets of $800,000 and makes an annual profit of $120,000. It should be assumed that if the investment described below is not undertaken, the division will continue to have net assets of $800,000 and an annual profit of $120,000 for the next four years. The division's financial performance is measured using residual income, and the division's cost of capital is 12%.

The divisional is considering an investment in a new item of equipment that would cost $80,000. The estimated life of the equipment is four years with no residual value. The estimated additional profit before depreciation from the investment is as follows:

Year	$
1	20,000
2	25,000
3	35,000
4	40,000

The asset will be depreciated on a straight-line basis.

Required: What would be the annual residual income on this investment? Notional interest should be calculated on the basis of the average net assets employed during the year.
Would the investment centre manager decide to undertake this investment or not?

a

Answer

	Year 1	Year 2	Year 3	Year 4
Workings: notional interest	$	$	$	$
Average investment	870,000	850,000	830,000	810,000
Notional interest at 12%	104,400	102,000	99,600	97,200
Calculation of residual income	$	$	$	$
Profit without investment	120,000	120,000	120,000	120,000
Additional profit before depreciation	20,000	25,000	35,000	40,000
Additional depreciation	(20,000)	(20,000)	(20,000)	(20,000)
Divisional profit	120,000	125,000	135,000	140,000
Notional interest (see workings)	(104,400)	(102,000)	(99,600)	(97,200)
Residual income	15,600	23,000	35,400	42,800

If the investment is not undertaken, the residual income in each year would be:

	$
Profit without investment	120,000
Notional interest (12% × $800,000)	(96,000)
Residual income	24,000

If the investment is undertaken, residual income would fall in Year 1 and Year 2, but increase in Year 3 and Year 4. If the divisional manager is most concerned about short-term financial performance, he would decide that the investment should not be undertaken, in spite of the longer-term addition to residual income.

3.4 Advantages and disadvantages of residual income

Advantages of residual income

There are several advantages in using residual income as a measure of the performance of an investment centre.

- It relates the profit of the division to the capital employed, by charging an amount of notional interest on capital employed, and the division manager is responsible for both profit and capital employed.
- Residual income is a flexible measure of performance, because a different cost of capital can be applied to investments with different risk characteristics.

Disadvantages of residual income

There are also disadvantages in using residual income as a measure of the performance of an investment centre.

- Residual income is an accounting-based measure, and suffers from the same problem as ROI in defining capital employed and profit.
- Its main weakness is that it is difficult to compare the performance of different divisions using residual income. Larger divisions should earn a bigger residual income than smaller divisions. A small division making residual income of $50,000 might actually perform much better than a much larger division whose residual income is $100,000, if performance s measured by ROI. This point is illustrated in the example below.
- Residual income is not easily understood by management, especially managers with little accounting knowledge.

Example

A company has two divisions, Small and Big. Big Division has net assets of $8 million and makes an annual profit of $900,000. Small Division has net assets of $400,000 and makes an annual profit of $90,000. The cost of capital for both divisions is 10%.

Required:
Compare the performance of the two divisions using:

(a) ROI

(b) Residual income.

Answer

	Big	Small
Profit	$900,000	$90,000
Net assets	$8 million	$400,000
ROI	11.25%	22.5%

	$	$
Profit	900,000	90,000
Notional interest	800,000	40,000
Residual income	100,000	50,000

Using ROI as a measure of performance, Small Division has performed better than Big Division. However Big Division has made a higher residual income, and it could therefore be argued that it has performed better than Small Division.

Divisional performance and depreciation

- ROI or RI: the problem with depreciation

4 Divisional performance and depreciation

4.1 ROI or RI: the problem with depreciation

If straight-line depreciation is used and capital employed is based on carrying values (net book values) the annual ROI and residual income will increase over time if:

- annual profits are constant, and
- assets are not replaced, and existing assets remain in use as they get older.

In the early years of an investment, the ROI or residual income may be very low. If a divisional manager is concerned about the effect that this would have on the division's ROI or residual income for the next year or two, the manager may refuse to invest in the project. This is because performance in the next year or so might be much worse, even though the project might be expected to earn a high return over its full economic life.

The tendency for ROI and residual income to increase over time if assets are not replaced means that divisional managers may prefer to keep old and ageing assets in operation as long as possible – even though it might be preferable in the longer term to replace the assets sooner.

Example

A company has just opened a new division that will operate as an investment centre. The following estimates of future performance have been made.

The division requires an investment of $5 million. This consists entirely of new non-current assets. Non-current assets will be depreciated at the rate of 25% of cost each year, and there will be no residual value after four years.

Sales revenue in the first year will be $10.8 million, but in subsequent years will change as follows:

(1) There will be no change in selling prices in Year 2, but prices will be reduced by 5% in Year 3 and by a further 5% in Year 4.

(2) Sales volume will increase by 10% in Year 2 and a further 10% in Year 3, but sales volume in Year 4 will be the same as in Year 3.

Costs estimates are as follows.

(1) Gross profit will be 40% in Year 1, but will change as prices are reduced in Years 3 and 4.

(2) There will be no change in the cost of sales per unit sold: prices per unit for cost of goods sold will remain stable.

(3) Annual overheads including depreciation will be \$3.5 million in Year 1 and Year 2 and \$4 million in Years 3 and 4.

Required

Calculate for each of years 1 – 4: residual income each year

(a) Sales revenue

(b) Gross profit

(c) Net profit

(d) ROI, assuming that capital employed is the net book value of the investment in the division as at the beginning of the year.

Comment on the figures.

a

	Year 1	Year 2	Year 3	Year 4
	\$m	\$m	\$m	\$m
Sales revenue (working 1)	10.800	11.880	12.415	11.794
Cost of sales (working 2)	6.480	7.128	7.841	7.841
Gross profit	4.320	4.752	4.574	3.953
Overheads	3.500	3.500	4.000	4.000
Net profit/(loss)	0.820	1.252	0.574	(0.047)
Net assets at beginning of year	5.00	3.75	2.50	1.25
ROI	16.4%	33.4%	23.0%	(1.3)%
Gross profit margin	40.0%	40.0%	36.8%	33.5%
Net profit margin	7.6%	10.5%	4.6%	0%

Workings

(1) **Sales revenue** = Revenue in previous year × Price change × Sales volume change

Year 2: \$10.8 million × 100% × 1.10 = \$11.88 million

Year 3: \$11.88 million × 95% × 1.10 = \$12.4146 million, say \$12.415 million

Year 4: \$12.4146 million × 95% × 1.0 = \$11.79387 million, say \$11.794 million.

(2) **Cost of sales** = 60% of sales in Year 1. The total cost of sales will then vary each year with changes in sales volume.

Year 1: Cost of sales = 60% × \$10.8 million = \$6.48 million
Year 2: Cost of sales = \$6.48 million × 1.10 = \$7.128 million
Year 3: Cost of sales = \$7.128 million × 1.10 = \$7.8408 million, say \$7.841 million.
Year 4: Same as Year 3 (no change in sales volume).

(3) **Net assets**: \$5 million at the beginning of Year 1, reducing by (25%) \$1.25 million in each subsequent year.

Analysis
There is a tendency for ROI to increase as non-current assets get older. This is most apparent in Year 2, when ROI increases from 16.4% to 33.4%, largely because of the reduction in the value of the investment in the division. ROI would also increase in Year 3 and Year 4, but the effect of changes in selling prices and overhead costs mean that the net effect is a reduction in ROI in those years (and also in the gross profit and net profit margins).

ROI is affected in Year 3 by the first 5% fall in sales and the increase in overhead costs by \$500,000. In Year 4, performance gets worse, in spite of the fall in net assets to \$1.25 million, because of the further fall in sales prices and gross profit margin. In year 4 there is even a small net loss.

CHAPTER 14

Transfer pricing

Contents

Transfer pricing: purpose and objectives

- Purpose of transfer pricing
- Definition of a transfer price
- Transfers at cost
- Transfer pricing at cost plus
- Transfer pricing at market price
- The objectives of transfer pricing

1 Transfer pricing: purpose and objectives

1.1 Purpose of transfer pricing

When a company has a divisionalised structure, some of the divisions might supply goods or services to other divisions in the same company.

- One division sells the goods or services. This will be referred to as the 'selling division'.
- Another division buys the goods or services. This will be referred to as the 'buying division'.

For accounting purposes, these internal transfers of goods or services are given a value. Transfers could be recorded at cost. However, when the selling division is a profit centre or investment centre, it will expect to make some profit on the sale.

1.2 Definition of a transfer price

A transfer price is the price at which goods or services are sold by one division within a company to another division in the same company. Internal sales are referred to as transfers, so the internal selling and buying price is the transfer price.

When goods are sold or transferred by one division to another, the sale for one division is matched by a purchase by the other division, and total profit of the company as a whole is unaffected. It is an internal transaction within the company, and a company cannot make a profit from internal transfers.

A decision has to be made about what the transfer price should be. A transfer price may be:

- the cost of the item (to the selling division), or
- a price that is higher than the cost to the selling division, which may be cost plus a profit margin or related to the external market price of the item transferred.

1.3 Transfers at cost

The transfer price may be the cost of making the item (goods) or cost of provision (services) to the selling division. A transfer at cost may be at either:

- marginal cost (variable cost), or
- full cost.

Example

An entity has two divisions, Division A and Division B. Division A makes a component X which is transferred to Division B. Division B uses component X to make end-product Y. Details of budgeted annual sales and costs in each division are as follows:

	Division A	Division B
Units produced/sold	10,000	10,000
	$	$
Sales of final product	-	350,000
Costs of production		
Variable costs	70,000	30,000
Fixed costs	80,000	90,000
Total costs	150,000	120,000

Required
What would be the budgeted annual profit for each division if the units of component X are transferred from Division A to Division B:
(a) at marginal cost
(b) at full cost?

How would the reported profit differ if actual sales prices, actual variables costs per unit and total fixed costs were as budgeted, but units sold are 10% more than budget?

Answer

Transfers at marginal cost: budgeted performance:

	Division A	Division B	Company as a whole
Units produced/sold	10,000	10,000	10,000
	$	$	$
External sales of final product	-	350,000	350,000
Internal transfers (10,000 × $7)	70,000	-	0
Total sales	70,000	350,000	350,000

Costs of production			
Internal transfers (10,000 × $7)	-	70,000	0
Other variable costs	70,000	30,000	100,000
Fixed costs	80,000	90,000	170,000
Total costs	150,000	190,000	270,000
Profit/(net cost or loss)	(80,000)	160,000	80,000

For the company as a whole, the internal transfers are not included in sales and costs. The transfers affect the financial results of the divisions.

By transferring goods at variable cost, the transferring division earns revenue equal to its variable cost of production. It therefore bears the full cost of its fixed costs, and its records a loss (or a net cost) equal to its fixed costs.

On the other hand, the buying division (Division B) reports a profit. Because te fixed costs of Division A are not included in the transfer price, the profit of Division B exceeds the total profit of the company as a whole.

Transfers at marginal cost: actual sales higher than budget

The same situation occurs if actual output and sales differ from budget. If production and sales are 11,000 units, the profits of Division B will increase, but Division A still makes a loss equal to its fixed costs. The total company profits increase by the same amount as the increase in the profits of Division B.

	Division A	**Division B**	**Company as a whole**
Units produced/sold	11,000	11,000	11,000
	$	$	$
External sales of final product	-	385,000	385,000
Internal transfers (11,000 × $7)	77,000	-	0
Total sales	77,000	385,000	385,000
Costs of production			
Internal transfers (11,000 × $7)	-	77,000	0
Other variable costs	77,000	33,000	110,000
Fixed costs	80,000	90,000	170,000
Total costs	157,000	200,000	280,000
Profit/(net cost or loss)	(80,000)	185,000	105,000

Transfers at full cost: budgeted performance:
In this example, the full cost per unit produced in Division A is $15, with an absorption rate for fixed overheads of $8 per unit produced and transferred.

	Division A	Division B	Company as a whole
Units produced/sold	10,000	10,000	10,000
	$	$	$
External sales of final product	-	350,000	350,000
Internal transfers (10,000 × $15)	150,000	-	0
Total sales	150,000	350,000	350,000
Costs of production			
Internal transfers (10,000 × $15)	-	150,000	0
Other variable costs	70,000	30,000	100,000
Fixed costs	80,000	90,000	170,000
Total costs	150,000	270,000	270,000
Profit	0	80,000	80,000

Since the transfer price includes the fixed costs of the selling division, Division A is able to cover all its costs, but it reports neither a profit nor a loss. It covers its costs exactly.

The buying division (Division B) has to pay for the fixed costs of division A in the transfer price. It still reports a profit, but this profit is now equal to the profit earned by the company as a whole.

Transfers at full cost: actual sales higher than budget

A similar situation occurs if actual output and sales differ from budget. If production and sales are 11,000 units, the profits of Division B will increase. However, Division A will make some 'profit', but this is simply the amount by which its fixed overhead costs are over-absorbed.

	Division A	Division B	Company as a whole
Units produced/sold	11,000	11,000	11,000
	$	$	$
External sales of final product	-	385,000	385,000
Internal transfers (11,000 × $15)	165,000	-	0
Total sales	165,000	385,000	385,000
Costs of production			

Internal transfers (11,000 × $15)	-	165,000	0
Other variable costs	77,000	33,000	110,000
Fixed costs (incurred)	80,000	90,000	170,000
Total costs	157,000	288,000	280,000
Profit	8,000	97,000	105,000

These examples should illustrate that if transfers are at cost, the selling division has no real incentive, because it will earn little or no profit from the transactions. In effect, the selling division is a cost centre rather than a profit centre or investment centre.

1.4 Transfer pricing at cost plus

For the purpose of performance measurement and performance evaluation in a company with profit centres or investment centres, it is appropriate that:

- the selling division should earn some profit or return on its transfer sales to other divisions and
- the buying division should pay a fair transfer price for the goods or services that it buys from other divisions.

One way of arranging for each division to make a profit on transfers is to set the transfer price at an amount above cost, to provide the selling division with a profit margin. However the transfer price should not be so high that the buying division makes a loss on the items it obtains from the selling division.

Example

An entity has two divisions, Division C and Division D. Division C makes a component Y which is transferred to Division D. Division D uses component Y to make end-product Z. Details of budgeted annual sales and costs in each division are as follows:

	Division C	**Division D**
Units produced/sold	10,000	10,000
	$	$
Sales of final product	-	350,000
Costs of production		
Variable costs	70,000	30,000
Fixed costs	80,000	90,000
Total costs	150,000	120,000

Required
What would be the budgeted annual profit for each division if the units of component Y are transferred from Division C to Division D at full cost plus 20%?

Answer

The full cost per unit produced in Division C is $15, and the transfer price (full cost plus 20%) is $18.

	Division C	Division D	Company as a whole
Units produced/sold	10,000	10,000	10,000
	$	$	$
External sales of final product	-	350,000	350,000
Internal transfers (10,000 × $18)	180,000	-	0
Total sales	180,000	350,000	350,000
Costs of production			
Internal transfers (10,000 × $18)	-	180,000	0
Other variable costs	70,000	30,000	100,000
Fixed costs	80,000	90,000	170,000
Total costs	150,000	300,000	270,000
Profit	30,000	50,000	80,000

A cost plus transfer price succeeds in sharing the total company profit between the two divisions. However, the transfer price is arbitrary, because the profit margin of 20% is arbitrary. If the transfer price lacks commercial reality, the reported profits of each division are not satisfactory measures of performance.

1.5 Transfer pricing at market price

It would be more realistic to set the transfer price at or close to a market price for the item transferred, but this is only possible if an external market exists for the item.

Example

An entity has two divisions, Division G and Division K. Division G makes a component P which is transferred to Division K. Division K uses component P to make end-product Q.

Division G budgets to sell one half of its output to Division K and the other half to external customers. The market price for component P is $16 per unit and it has been agreed that transfers between the two divisions should be at market price.

Details of budgeted annual sales and costs in each division are as follows:

	Division G	Division K
Units produced/sold	20,000	10,000
	$	$
Sales of final product	160,000	350,000
Costs of production		
Variable costs	140,000	30,000
Fixed costs	80,000	90,000
Total costs	150,000	120,000

Required
What would be the budgeted annual profit for each division if the units of component Y are transferred from Division G to Division K at market price?

a

Answer

	Division G	Division K	Company as a whole
Units produced/sold	20,000	10,000	10,000
	$	$	$
External sales of product Q	-	350,000	350,000
External sales of component P	160,000	-	160,000
Internal transfers (10,000 × $16)	160,000	-	0
Total sales	320,000	350,000	510,000
Costs of production			
Internal transfers (10,000 × $21)	-	160,000	0
Other variable costs (20,000 × $7)	140,000	30,000	170,000
Fixed costs	80,000	90,000	170,000
Total costs	220,000	280,000	340,000
Profit	100,000	70,000	170,000

Because transfers are at market price, it can be argued that the profit of each division is a reasonable measure of their financial performance.

1.6 The objectives of transfer pricing

Transfer prices are decided by management. When authority is delegated to divisional managers, the managers of the selling and buying divisions should be given the authority to negotiate and agree the transfer prices for any goods or services 'sold' by one division to the other.

The objectives of transfer pricing should be to make it possible for divisionalisation to operate successfully within a company, and:

- give autonomy (freedom to make decisions) to the managers of the profit centres or investment centres
- enable the company to measure the performance of each division in a fair way.

Divisional autonomy

Autonomy is freedom of action and freedom to make decisions. Divisional managers should be free to make their own decisions. Autonomy should improve motivation of divisional managers.

For example, when transfer prices have been decided, the managers of all divisions within the entity should be free to decide:

- whether to sell their output to other divisions (internal transfers) or whether to sell them to external customers, if an external market exists for the output
- whether to buy their goods from another division (internal transfers) or whether to buy them from external suppliers, if an external market exists.

Acting in the best interests of the company

In addition, divisional managers should be expected to make decisions that are in the best interest s of the company as a whole.

Unfortunately, divisional managers often put the interests of their own division before the interests of the company as a whole, particularly if they are rewarded (for example with an annual cash bonus) on the basis of the profits or ROI achieved by the division.

In certain circumstances, the personal objectives of divisional managers may be in conflict with the interests of the company as a whole. A division may take action that maximises its own profit, but reduces the profits of another division. As a result, the profits of the entity as a whole may also be reduced.

Problems with transfer pricing

- External intermediate markets
- Market-based and cost-based transfer prices, and transfer prices based on opportunity cost
- The opportunity cost of transfers
- Identifying the ideal transfer price
- Finding the ideal transfer price: No external intermediate market
- Finding the ideal transfer price: An external intermediate market and no production limitations
- Finding the ideal transfer price: An external intermediate market and production limitations

2 Problems with transfer pricing

2.1 External intermediate markets

A system of transfer pricing should allow the divisional managers the freedom to make their own decisions, without having to be told by head office what they must do. At the same time, the system should not encourage divisional managers to take decisions that do harm to the company.

The main problems arise when there is an external market for the goods (or services) that one division transfers to another. When an external market exists for goods or services that are also transferred internally, the market might be called an **external intermediate market**.

- The selling division can sell its goods into this market, instead of transferring them internally.
- Similarly the buying division can buy its goods from other suppliers in this market, instead of buying them internally from another division.

Divisional managers will put the interests of their division before the interests of the company. When there is an external intermediate market, divisional managers will decide between internal transfers and using the external market in a way that maximises the profits of their division.

2.2 Market-based and cost-based transfer prices, and transfer prices based on opportunity cost

As a general rule:

- when an external intermediate market does not exist for transferred goods, the transfer price will be based on cost
- when an external intermediate market does exist for transferred goods, the transfer price will be based on the external market price.

However, the situation is more complicated when:

- there is a **limit to production capacity in the selling division**, or
- there is a **limit to sales demand in the external intermediate market**.

In these circumstances, we need to consider the **opportunity costs** for the selling division of transferring goods internally instead of selling them externally.

2.3 The opportunity cost of transfers

The selling division and the buying division have opportunity costs of transferring goods internally when there is an intermediate external market.

- For the selling division, the opportunity cost of transferring goods internally to another division might include a loss of contribution and profit from not being able to sell goods externally in the intermediate market.
- For the buying division, the opportunity cost of buying internally from another division is the price that it would have to pay for purchasing the items from external suppliers in the intermediate market.

The ideal transfer price is a price at which both the selling division and the buying division will want to do what is in the best interests of the company as a whole, because it is also in the best interests of their divisions.

Ideal transfer prices must therefore take opportunity costs into consideration.

2.4 Identifying the ideal transfer price

The following rules should help you to identify the ideal transfer price in any situation:

- **Step 1**. Begin by identifying the arrangement for transferring goods internally that would maximise the profits of the company as a whole. In other words, what solution is best for the company?
- **Step 2**. Having identified the plan that is in the best interests of the company as a whole, identify the transfer price, or range of transfer prices, that will make the manager of the buying division want to work towards this plan. The transfer price must ensure that, given this transfer price, the profits of the division will be maximised by doing what is in the best interests of the company as a whole.
- **Step 3**. In the same way, having identified the plan that is in the best interests of the company as a whole, identify the transfer price, or range of transfer prices, that will make the manager of the selling division want to work towards the same plan. Again, the transfer price must ensure that, given the transfer price, the profits of the division will be maximised by doing what is in the best interests of the company as a whole.

These rules will be illustrated with a number of different examples and different situations.

2.5 Finding the ideal transfer price: No external intermediate market

When there is no external intermediate market, the ideal transfer price is either:

- cost or
- cost plus a contribution margin or profit margin for the selling division.

Transfers at cost do not provide any profit for the selling division; therefore transfer prices at cost are inappropriate for a divisional structure where the selling division is a profit centre or an investment centre, with responsibility for making profits. Transfers at cost are appropriate only if the selling division is treated as a cost centre, with responsibility for controlling its costs but not for making profit.

If the selling division is a profit centre or an investment centre, and there is no external intermediate market for the transferred item, transfers should therefore be at a negotiated 'cost plus' price, to provide some profit to the selling division.

Example

A company has two divisions, Division A and Division B. Division A makes a component X which is transferred to Division B. Division B uses component X to make end-product Y. Both divisions are profit centres within the company.

Details of costs and selling price are as follows:

Division A	**$**
Cost of component X	
Variable cost	10
Fixed cost	8
Total cost	18
Division B	
Further processing costs	
Variable cost	4
Fixed cost	7
	11
Selling price per unit of product Y	40

The further processing costs of Division B do not include the cost of buying component X from Division A. One unit of component X goes into the production of one unit of Product Y. Fixed costs in both divisions will be the same, regardless of the volume of production and sales.

Required

What is the ideal transfer price, or what is a range of prices that would be ideal for the transfer price?

a

Answer

Step 1

What is in the best interests of the company as a whole?

The total variable cost of one unit of the end product, product Y, is $14 ($10 + $4). The sales price of product Y is $40. The entity therefore makes additional contribution of $26 for every unit of product Y that it sells. It is therefore in the best interests of the company to maximise production and sales of product Y.

Step 2

What will motivate the buying division to buy as many units of component X as possible?

Division B will want to buy more units of component X provided that the division earns additional contribution from every unit of the component that it buys.

Division B	**$**
Selling price of Product Y, per unit	40
Variable further processing costs in Division B	4
	36

The opportunity cost of not buying units of component X, ignoring the transfer price, is $36 per unit. Division B should therefore be willing to pay up to $36 per unit for component X. Any transfer price below $36 but above $4 per unit will increase its contribution and profit

Step 3

What will motivate the selling division to make and transfer as many units of component X as possible?

Division A will want to make and sell more units of component X provided that the division earns additional contribution from every unit of the component that it sells.

The marginal cost of making and transferring a unit of component X is $10. Division A should therefore be willing to transfer as many units of component X as it can make (or Division B has the capacity to buy) if the transfer price is at least $10.

Ideal transfer price

The ideal transfer price is anywhere in the range $10 to $36. A price somewhere within this range may be negotiated, which will provide profit to both divisions and the company as a whole, for each additional unit of product Y that is made and sold.

2.6 Finding the ideal transfer price: An external intermediate market and no production limitations

When there is an external intermediate market for the transferred item, a different situation applies. If there are no production limitations in the selling division, the ideal transfer price is usually the external market price.

Example

A company has two divisions P and Q. Division P makes a component X which it either transfers to Division Q or sells in an external market. The costs of making one unit of component X are:

Component X	$
Variable cost	60
Fixed cost	30
Total cost	90

Division Q uses one unit of component X to make one unit of product Y, which it sells for $200 after incurring variable further processing costs of $25 per unit.

Required

What is the ideal transfer price or range of transfer prices, if the price of component X in the external intermediate market is:

(a) $140

(b) $58?

Answer

Step 1

What is in the best interests of the company as a whole?

The company will benefit by maximising the total contribution from the total external sales of component X and product Y.

If component X is not transferred by Division P to Division Q, Division Q will have to buy units of component X in the external market. Every unit of component X transferred internally therefore reduces the need to purchase a unit externally.

- The additional contribution for the company from making and selling one unit of product Y is $115 ($200 – $60 – $25).
- The additional contribution from making one unit of component X and selling it externally is $80 ($140 – $60) when the external price is $140.
- When the external market rice is $58 for component X, Division P would make an incremental loss of $2 per unit ($58 – $60) by selling the component externally.

A profit-maximising plan is therefore to maximise the sales of Division Q, and transfer component X from Division P to Division Q rather than sell component X externally. This is the optimum plan if the external price for component X is either $140 or $58.

Step 2

What will motivate the buying division (Division Q) to buy as many units of component X as possible from Division P?

Division Q will be prepared to buy component X from Division P as long as it is not more expensive than buying in the external market from another supplier. Division Q will be willing to buy internally if the transfer price is:

(a) not more than $140 when the external market price is $140

(b) not more than $58 when the external market price is $58.

If the external market price and transfer price are both $140, Division Q will make an incremental contribution of $35 ($200 – $140 – $25) from each unit of component X that it buys and uses to make and sell a unit of product Y.

If the external market price and transfer price are both $58, Division Q will make an incremental contribution of $117 ($200 – $58 – $25) from each unit of component X that it buys and uses to make and sell a unit of product Y.

It the transfer price is higher than the external market price, Division Q will choose to buy component X in the external market, which would not be in the best interests of the company as a whole.

Step 3

What will motivate the selling division to make and transfer to Division Q as many units of component X as possible?

Division P should be prepared to transfer as many units of component X as possible to Division Q provided that its profit is no less than it would be if it sold component X externally.

Units transferred to division Q are lost sales to the external market; therefore there is an opportunity cost of transfer that Division P will wish to include in the transfer price.

Component X: market price $140	**$**
Variable cost	60
Opportunity cost of lost external sale (140 – 60)	80
Total cost = minimum transfer price	140

Component X: market price $58	**$**
Variable cost	60
Opportunity cost of lost external sale (58 – 60)	(2)
Total cost = minimum transfer price	58

Ideal transfer price

The ideal transfer price is the maximum that the buying division is prepared to pay and the minimum that the selling division will want to receive. In both situations, the ideal transfer price is therefore the market price in the external intermediate market.

When the external market price is $58, Division P is losing contribution by selling component X externally. It would also be cheaper for the entity as a whole to buy the component externally for $58 rather than make internally for a marginal cost of $60. Division P should consider ending its operations to produce component X.

2.7 Finding the ideal transfer price: An external intermediate market and production limitations

When there is an external intermediate market for the transferred item, and the selling division has a limitation on the number of units it can produce, the ideal transfer price should allow for the opportunity cost of the selling division. Every unit transferred means one less external sale.

Example

A company consists of two divisions, Division A and Division B. Division A is working at full capacity on its machines, and can make either Product Y or Product Z, up to its capacity limitation. Both of these products have an external market.

The costs and selling prices of Product Y and Product Z are:

	Product Y	Product Z
	$	$
Selling price	15	17
Variable cost of production	10	7
Variable cost of sale	1	2
Contribution per unit	4	8

The variable cost of sale is incurred on external sales of the division's products. This selling cost is not incurred for internal sales/transfers from Division A to Division B.

To make one unit of Product Y takes exactly the same machine time as one unit of Product Z.

Division B buys Product Y, which it uses to make an end product.

The profit of the company as a whole will be maximised by making and selling as many units as possible of Division B's end product.

Required

What is the ideal transfer price or range of transfer prices?

a

Answer

Step 1

What is in the best interests of the company as a whole?

This is stated in the example. The company wants to make and sell as many units of the end product of Division B as possible. It is not clear, however, whether it is better for Division B to buy Product Y externally or to buy internally from Division A.

If Division A does not make Product Y, it can make and sell Product Z instead. Product Z earns a higher contribution per unit of machine time, the limiting factor in Division A.

Step 2

What would motivate the buying division to buy as many units of Product Y as possible from Division A?

Division B will be prepared to buy Product Y from Division A as long as it is not more expensive than buying in the external market from another supplier.

Division B will be willing to buy Product Y internally if the transfer price is $15 or less.

Step 3

What would motivate the selling division to make and transfer as many units of Product Y as possible?

The selling division will only be willing to make Product Y instead of Product Z if it earns at least as much contribution as it would from making Z and selling it externally. (In this situation, the division can make as many units of Z as it can make of Y, and Product Z earns a higher contribution).

Product Y	**$**
Variable cost of making Product Y (the variable cost of sale is not relevant for internal transfers)	10
Opportunity cost of lost external sale of Product Z (17 – 7 – 2)	8
Total cost = minimum transfer price	18

Ideal transfer price/ideal production and selling plan

Division B will not want to pay more than $15 for transfers of Product Y; otherwise it will buy Product Y externally.

Division A will want to receive at least $18 for transfers of Product Y; otherwise it will prefer to make and sell Product Z, not Product Y.

The ideal solution is for Division B to buy Product Y externally at $15 and for Division A to make and sell Product Z.

Example

A company consists of two divisions, Division A and Division B. Division A is operating at full capacity making Product X, for which there is an external market. The variable cost of making one unit of Product X is $70, and the sale price of Product X in the external market is $100 per unit.

Division B needs one unit of Product X to manufacture another product, Product Y. The variable conversion costs and further processing costs in Division B are $29 per unit of Product Y. The external selling price of Product Y is $140 per unit.

An external supplier has offered to sell units of Product Y to Division B for $103 per unit.

Required

(a) Identify the ideal transfer price.

(b) Calculate the contribution per unit for each Division and for the company as a whole if this transfer price is used.

(c) Suggest with reasons whether this transfer price provides a fair measure of divisional performance.

Answer

Step 1

What is in the best interests of the company as a whole?

- For each additional unit of Product Y that Division B makes and sells, the additional contribution for the company is $41 ($140 – $70 – $29).
- The contribution from selling one unit of Product Y in the intermediate market is $30 ($100 – $70).

The company therefore makes more contribution and profit from making and selling Product Y than from selling Product X externally.

The production plan that will optimise the profit for the company as a whole is for Division A to make units of Product X and transfer them to Division B.

Step 2

What would motivate the buying division to buy as many units of Product X as possible from Division A?

Division B will not want to pay more to Division A for Product X than the price it has been offered by an external supplier, $103. However, Division B can presumably find another supplier who is willing to offer the current market price of $100, and the maximum price that Division B should pay ought to be $100.

Step 3

What would motivate the selling division to make and transfer as many units of Product X as possible?

Product Y	**$**
Variable cost	70
Opportunity cost of lost external sale (100 – 70)	30
Total cost = minimum transfer price	100

Ideal transfer price

The ideal transfer price is $100 per unit of Product X.

Contribution per unit

	Division A	**Division B**	**Entity as a whole**
	$/unit	$/unit	$/unit
External sale	-	140	140
Internal sale	100	-	-
Sales revenue	100	140	140
Transfer: purchase cost	-	100	-
Other variable costs	70	29	99
Total variable costs	70	129	99
Contribution per unit	30	11	41

Comment

The contribution per unit for each division is a fair representation of the economic contribution of each division to the profitability of the company as a whole.

The transfer price therefore provides an appropriate measurement of divisional performance.

Transfer pricing in practice

- Transfer price at market price
- Transfer price at full cost plus
- Transfer price at variable cost plus or incremental cost plus
- Two-part transfer prices
- Dual pricing
- Negotiated transfer prices
- Transfer pricing in multinational groups

3 Transfer pricing in practice

Transfer prices might be decided by head office and imposed on each division. Alternatively, the managers of each division might have the autonomy to negotiate transfer prices with each other.

In practice, transfer prices may be agreed and expressed in one of the following ways.

3.1 Transfer price at market price

A transfer price may be the external selling/buying price for the item in an external intermediate market. This price is only possible when an external market exists.

If the selling division would incur some extra costs if it sold its output externally rather than transferred it internally to another division, the transfer price may be reduced below market price, to allow for the variable costs that would be saved by the selling division. This is very common as the selling division may save costs of packaging and warranties or guarantees. Distribution costs may also be cheaper and there will be no need for advertising.

Advantages of market price as the transfer price

Market price is the ideal transfer price when there is an external market. A transfer price below this amount will make the manager of the selling division want to sell externally, and a price above this amount will make the manager of the buying division want to buy externally.

Transferring at market price also encourages efficiency in the supplying division, which must compete with the external competition.

Disadvantages of market price as the transfer price

The current market price is not appropriate as a transfer price when:

- the current market price is only temporary, and caused by short-term conditions in the market, or
- the selling price in the external market would fall if the selling division sold more of its output into the market. The opportunity cost of transferring output internally would not be the current market price, because the selling price would have to be reduced in order to sell the extra units.

It may also be difficult to identify exactly what the external market price is. Products from rival companies may be different in quality, availability may not be so certain and there may be different levels of service back-up.

3.2 Transfer price at full cost plus

A transfer price may be the full cost of production plus a margin for profit for the selling division.

Standard full costs should be used, **not actual full costs**. This will prevent the selling division from increasing its profit by incurring higher costs per unit.

Full cost plus might be suitable when there is no external intermediate market.

However, there are disadvantages in using full cost rather than variable cost to decide a transfer price.

- The fixed costs of the selling division become variable costs in the transfer price of the buying division. This might lead to decisions by the buying division manager that are against the best interests of the company as a whole. This is because a higher variable cost may lead to the buying division choosing to set price at a higher level which would lose sales volume.
- The size of the profit margin or mark-up is likely to be arbitrary.

3.3 Transfer price at variable cost plus or incremental cost plus

A transfer price might be expressed as the variable cost of production plus a margin for profit for the selling division.

Standard variable costs should be used, **not actual variable costs**. This will prevent the selling division from increasing its profit by incurring higher variable costs per unit.

Variable cost plus might be suitable when there is no external intermediate market. It is probably more suitable in these circumstances than full cost plus, because variable cost is a better measure of opportunity cost. However, as stated earlier, when transfers are at cot, the transferring division should be a cost centre, and not a profit centre.

Other methods that may be used to agree transfer prices include:

- Two-part transfer prices
- Dual pricing

3.4 Two-part transfer prices

With two-part transfer prices, the selling division charges the buying division for units transferred in two ways:

- a standard variable cost per unit transferred, plus
- a fixed charge in each period.

The fixed charge is a lump sum charge at the end of each period. The fixed charge would represent a share of the contribution from selling the end product, which the selling/transferring division has helped to earn. Alternatively, the charge could be seen as a charge to the buying division for a share of the fixed costs of the selling division in the period.

The fixed charge could be set at an amount that provides a 'fair' profit for each division, although it is an arbitrary amount.

3.5 Dual pricing

In some situations, two divisions may not be able to agree a transfer price, because there is no transfer price at which the selling division will want to transfer internally or the buying division will want to buy internally. However, the profits of the entity as a whole would be increased if transfers did occur.

These situations are rare. However, when they occur, head office might find a solution to the problem by agreeing to dual transfer prices.

- the selling division sells at one transfer price, and
- the buying division buys at a lower transfer price.

There are two different transfer prices. The transfer price for the selling division should be high enough to motivate the divisional manager to transfer more units to the buying division. Similarly, the transfer price for the buying division should be low enough to motivate the divisional manager to buy more units from the selling division.

In the accounts of the company, the transferred goods are:

- sold by the selling division to head office and
- bought by the buying division from head office.

The loss from the dual pricing is a cost for head office, and treated as a head office overhead expense.

However, dual pricing can be complicated and confusing. It also requires the intervention of head office and therefore detracts from divisional autonomy.

3.6 Negotiated transfer prices

A negotiated transfer price is a price that is negotiated between the managers of the profit centres.

The divisional managers are given the autonomy to agree on transfer prices. Negotiation might be a method of identifying the ideal transfer price in situations where an external intermediate market does not exist.

An **advantage** of negotiation is that if the negotiations are honest and fair, the divisions should be willing to trade with each other on the basis of the transfer price they have agreed.

Disadvantages of negotiation are as follows:

- The divisional managers might be unable to reach agreement. When this happens, management from head office will have to act as judge or arbitrator in the case.
- The transfer prices that are negotiated might not be fair, but a reflection of the bargaining strength or bargaining skills of each divisional manager.

CHAPTER 15

Performance analysis in not-for-profit organisations and the public sector

Contents

Performance measurement in not-for-profit organisations and the public sector

- The special characteristics of not-for-profit organisations and the public sector
- The need for performance measurement
- Identifying performance targets in not-for-profit and public sector organisations
- Problems with measuring performance in this sector

1 Performance measurement in not-for-profit organisations and the public sector

1.1 The special characteristics of not-for-profit organisations and the public sector

The public sector refers to the sector of the economy that is owned or controlled by the government in the interests of the general public. It includes all government departments and government-financed bodies, including nationalised industries. In the UK, this includes the national health service, state-owned schools, the police and fire services, and so on.

Not-for-profit organisations are entities that are not government-owned or in the public sector, but which are not in existence to make a profit. They include charitable organisations and professional bodies.

A common feature of public sector organisations and not-for-profit organisations is that their main objective is not financial. The main objective of any such organisation depends on the purpose for which it exists: to administer the country (government departments), to provide education (schools and universities), provide medical care (hospitals), do charitable work, and so on.

A not-for-profit organisation will nevertheless have some financial objectives:

- State-owned organisations must operate within their spending budget.
- Charitable organisations may have an objective of keeping running costs within a certain limit, and of raising as much funding as possible for their charity work.

1.2 The need for performance measurement

Although the main objective of not-for-profit and public sector organisations is not financial, they need good management, and their performance should be measured and monitored. In many countries, including the UK, public sector organisations are given a range of performance targets, against which actual performance is compared.

- The directors of a company are accountable to their shareholders for the performance of the company. This is a function of the annual report and accounts, although accountability is also achieved in other ways, such as general meetings of the company.

- In a similar way, the directors or senior managers of public sector bodies should be accountable to the public. In practice, this usually means accountability to the government, which in turn should be accountable to the public.
- The leaders of not-for-profit organisations outside the public sector should also be accountable to the people who provide the finance to keep them in existence. For a professional body such as an institute of accountants, there should be accountability to the membership. For charities, there should be accountability to the providers of charitable donations, which may include government bodies.

Within a company, there should be a system of performance measurement at all levels of management. The same should apply to the management of public sector bodies and not-for-profit organisations. Managers should be made accountable to their bosses for the way in which they have managed the operations within their area of responsibility.

Since the main objective of these organisations is not financial, the main performance targets and measurements of performance should not be financial either. Performance measurement should be related to achieving targets that will help the organisation to achieve its objectives, whatever these may be.

1.3 Identifying performance targets in not-for-profit and public sector organisations

You may be required in your examination to suggest quantitative targets for a not-for-profit organisation. The selection of appropriate targets will vary according to the nature and purpose of the organisation. The broad principle, however, is that any not-for-profit organisation should have:

- strategic targets, mainly non-financial in nature
- operational targets, which may be either financial (often related to costs and keeping costs under control) or non-financial (related to the nature of operations).

Although there are no widely-recognised models for performance measurement in these organisations, it may help to think of performance models for business entities that include non-financial performance indicators, such as the building block model of Fitzgerald and Moon.

You may be given a small case study in your examination involving a public sector organisation, or a not-for-profit organisation, and you may be required to suggest a number of suitable performance targets. To deal with this type of question, you need to:

- Decide what the objectives of the organisation are
- Identify what the managers of the organisation (or area of management responsibility within the organisation) must do to achieve those objectives
- Identify a suitable way of measuring performance to judge whether those objectives are being achieved.

Example

The key objectives of a state-owned school may be set by the government. The government may also set specific targets that schools are expected to achieve: these are likely to be related to the quality of education provided. In addition, the school's management may also set other objectives that they consider important for the school.

Suitable performance targets may include the following measures of the quality of education:

- target pass rate in examinations
- numbers or percentage of students going to university
- average class sizes
- ratio of teacher numbers to student numbers.

The school will also be expected to operate within the expenditure budget that is allocated to it, and to raise the money for any additional expenditure by other methods, such as obtaining money from parents of the school children.

The school's management may also have an objective of survival for the school, and to ensure survival there may be targets for the annual intake of new students.

Supporting these overall objectives for the school, management may develop more detailed targets for particular aspects of school activity, or particular 'departments'. For example there may be an objective of developing the IT skills of the school children, and performance targets that may be set include:

- Targets for the ratio of computers or terminals to schoolchildren
- Minimum time spent by children each week on computers
- Targets for the replenishment of existing software with more up-to-date software
- Targets for annual spending on computer hardware and software.

1.4 Problems with measuring performance in this sector

A good performance measurement system seeks to monitor the success of an organisation in achieving its objectives. To do this it must

- have clear objectives
- set targets which are linked to objectives
- measure performance against these targets.

However, there are several reasons why the problems with performance measurement in the public sector are greater than those in commercial business organisations.

Multiple objectives

An organisation in the public sector (and also not-for-profit organisations) may have a number of different 'main objectives', and they are required to achieve all these objectives within the constraint of limited available finance.

When there are multiple non-financial objectives and limited finance, the various objectives will come into conflict. It will be impossible to achieve one objective without making compromises that could mean failure to achieve another objective.

It may be difficult to decide which of the conflicting objectives are most important, or to agree on a suitable compromise between the different objectives. Conflicts between multiple objectives are likely to exist in virtually every public sector organisation. At a strategic level, here are just a few examples.

State schools:

- The objective of a state-owned education system should be to provide a high standard of education for all children, with minimum targets for key learning objectives such as standards in reading, writing and arithmetic.
- However another objective should be to ensure that there is a place available in state schools for every child. If funding for state education is limited, it may be necessary to accept that education standards will not be as high as they should be and that privately-owned schools should be allowed to operate and take some children who would otherwise have to be educated in state schools.

State health service:

- The objective of a state-run health service should be to provide a high standard of health services to the population. However, given the limited finance and resources available, spending money on some aspects of the health service will mean less money for other aspects. Spending more money on hospitals could mean spending less on mental health or on care for the elderly.

Expectations of different stakeholders

In the public sector, the interests of different stakeholder groups are often important, and each group may have different expectations of what the organisation should be trying to achieve.

Example

A school may have a variety of objectives. Employers and the government may all require high levels of examination results and school management may require a high intake of pupils. Pupils may aspire to develop their skills. Parents expect schools to teach life and community skills. This leads to difficulties in identifying targets.

- The main target may be the level of examination results. However, the success in achieving this target will depend on the ability of the pupils in the school as well as the skill of the teachers.
- Targets such as class sizes and ratio of teachers to pupils may impact on the ability to achieve a good level of examination results but these are measures of inputs into the school rather than outputs from the school.
- An attempt may be made to measure the value added to each pupil. This could be done by measuring a pupil's achievements on entering and leaving the school. However there are many difficulties inherent in such a system. Only

certain skills could be measured and it would be possible to coach a pupil in these particular skills to ensure good results. There would be great pressure to do this if performance of each school was measured on this basis and this affected the number and ability of pupils sent to the school.

- A performance measurement system focusing on a narrow range of measures can lead to other important objectives being overlooked. If targets are centered on literacy and numeracy then other skills, such as musical and sporting ability, may not be developed. This may de-motivate pupils and lead to a lowering of overall performance.

Political influence

It is reasonable to suppose that with state-owned organisations, the government should decide what the strategic objectives and targets should be. However in democratic societies, the views of different political parties may differ, and if there is a change of government, there may well be a change of priorities and targets.

Value for money

- How can performance be measured?
- Benchmarking
- Quantitative measures of efficiency

2 Value for money

2.1 How can performance be measured ?

The performance of not-for-profit organisations or departments of government may be assessed on the basis of value for money 'VFM'. Value for money is often referred to as the '3Es':

- economy
- efficiency
- effectiveness.

Economy

Economy means keeping spending within limits, and avoiding wasteful spending. It also means achieving the same purpose at a lower expense. A simple example of economy is found in the purchase of supplies. Suppose that an administrative department buys items of stationery from a supplier, and pays $2 each for pens. It might be possible to buy pens of the same quality to fulfil exactly the same purpose for $1.50 each. Economy would be achieved by switching to buying the $1.50 pens, saving $0.50 per pen with no loss of operating efficiency or effectiveness.

Efficiency

Efficiency means getting more output from available resources. Applied to employees, efficiency is often called 'productivity'. Suppose that an employee in the government's tax department processes 20 tax returns each day. Efficiency would be improved if the same individual increases the rate of output, and processes 25 tax returns each day, without any loss of effectiveness.

Effectiveness

Effectiveness refers to success in achieving end results or success in achieving objectives. Whereas efficiency is concerned with getting more outputs from available resources, effectiveness is concerned with achieving outputs that meet the required aims and objectives. For example, the effectiveness of treatment of a particular medical condition will be improved if the proportion of patients who are treated successfully rises from 80% to 90%.

Management accounting systems and reporting systems may provide information to management about value for money. Has VFM been achieved, and if so, how much and in what ways?

Value for money audits may be carried out to establish how much value is being achieved within a particular department and whether there have been improvements to value for money. Internal audit departments may carry out occasional VFM audits, and report to senior management and the manager of the department they have audited.

VFM as a public sector objective

Value for money is an objective that can be applied to any organisation whose main objective is non-financial but which has restrictions on the amount of finance available for spending. It could therefore be appropriate for all organisations within the public sector.

The objective of **economy** focuses on the need to avoid wasteful expenditure on items, and to keep spending within limits. It also helps to ensure that the limited finance available is spent sensibly. Targets could be set for the prices paid for various items from external suppliers. Audits by the government's auditors into departmental spending may be used to identify:

- any significant failures to control prices, and
- unnecessary expense.

The objective of **efficiency** focuses on the need to make full use of available resources. The objective of **effectiveness** focuses on the need to use resources for their intended purpose and achieve the objectives of the organisation.

Unfortunately, in practice government is often accused of wasteful spending, inefficient operations and failure to get anything done – these are all the 'traditional' faults of an over-sized bureaucracy!

Example

State-owned schools may be given a target that their pupils (of a specified age) must achieve a certain level of examination grades or 'passes' in a particular examination.

A VFM audit could be used to establish spending efficiency within a school.

- **Economy**. Was there any unnecessary spending? Could the same value have been obtained for lower spending?
- **Efficiency**. Have the school's resources been used efficiently? Could more output have been obtained from the available resources? Could the same results have been achieved with fewer resources? A study of efficiency might focus on matters such as teaching time per teacher per week, and the utilisation of resources such as science equipment and computer-based training materials.
- **Effectiveness**. The most obvious measurements of effectiveness are the number or percentage of pupils achieving the required examination 'passes', or the

grades of pass mark that they have achieved. Effectiveness is improved by increasing the pass rate.

2.2 Benchmarking

Benchmarking is the comparison of performance against the best practitioners, identifying gaps and seeking ways to improve.

Benchmarking may be a very effective method for organisations in the not-for-profit sector to achieve improvements in performance as often they are not in direct competition with other similar organisations.

Example

Local authorities provide many services to households in their geographical area. These may include rubbish collection, road maintenance and social services. By comparing performance statistics it may be possible to identify more cost effective ways of providing services which can lead to an improvement in services for everybody.

2.3 Quantitative measures of efficiency

Efficiency relates the quantity of resources to the quantity of output. This can be measured in a variety of ways

- Actual output/Maximum output for a given resource × 100%
- Minimum input to achieve required level of output/actual input × 100%
- Actual output/actual input × 100% compared to a standard or target

Example

A hospital has an operating theatre which can be utilised for 20 hours per day. The maximum number of operations that can be performed in any day is 40. If on a particular day 35 operations were performed, this represents

35/40 × 100% = 87.5% efficiency

A local authority must ensure that the refuse of all residents is collected each week for re-cycling. This normally requires 1,000 man hours. If in a particular week 900 man hours were used this represents

1,000/900 × 100% = 111.1% efficiency

Schools may have a standard pupil to teacher ratio of 27. If a particular school has 550 pupils and 21 teachers then the actual ratio is 26.2 which represents

27/26.2 × 1005 = 103.05% efficiency.

CHAPTER

16

Performance measurement: external considerations and behavioural aspects

Contents

External considerations in performance measurement

- The nature of external considerations in performance management
- Stakeholders
- Market conditions
- Allowance for competitors
- Allowing for external considerations

1 External considerations in performance measurement

1.1 The nature of external considerations in performance management

External considerations are factors that arise or exist outside an organisation, and within its external environment, that could have an impact on:

- the objectives that the organisation should try to achieve and the targets that it sets for those objectives, or
- its actual performance.

The external factors that affect an organisation vary according to the type of organisation and the environment in which it operates. Broad categories of external factors include:

- Political and legal developments: new laws may affect what a company is allowed to do or is nor permitted to do, and this change could affect its performance
- Economic conditions and economic developments
- Changes in public attitudes and behaviour
- Technological changes
- Competition in the market.

The study guide for the F5 syllabus mentions three external considerations specifically: stakeholders, market conditions and allowance for competitors.

1.2 Stakeholders

Stakeholders of a company are any organisations, individuals or groups with an interest in what the company does and how it performs. It is often convenient to group stakeholders into categories, such as shareholders, lenders, suppliers, customers, employees, the government and the general public.

Public sector entities and not-for-profit organisations also have different stakeholder groups.

The interests of each stakeholder group differ, and each group has different expectations about what the organisation should do. They also judge its performance in different ways.

- Shareholders in a company have invested money by buying shares. Their main expectation is likely to be that the company should provide good returns on investment, in the form of dividends or share price growth. They may expect the company to achieve annual growth in profits and dividends. Even if the company is making small profits or even making a loss, the shareholders may expect the company to maintain the same annual dividend payments.
- Lenders to a company expect to make a profit or return in the form of interest. There is some credit risk in lending, and the rate of interest should provide a sufficient reward for the risk that the lender is taking. Lenders will want the company to have a secure business, and will not want the company to take risks that could threaten its ability to make the interest payments and repay the lending at maturity.
- Major suppliers to a company may depend on the company for a large proportion of their profits. They will expect honest and fair dealing from the company, and they will expect to be paid on time, when payment falls due for goods purchased on credit.
- Customers of a company expect to receive value for the money they pay to buy the goods or services that the company provides. If they think they are receiving poor value, they are likely to switch to buying the products of competitors, or to finding an alternative product. For example, commuters using the train services of a local train company may object to a large increase in rail fares: since the train company may have a monopoly on the local train routes, some commuters may respond to the price increase by switching to car, bicycle or bus.
- Employees are stakeholders in a company because the company provides them with a job and possibly also career opportunities. They also have an interest in working conditions, such as hours of work.
- The government and the general public. Some large companies can have a major influence on a national economy. They provide work for large numbers of people, and they produce the goods or services that many people buy and rely on. In addition, companies are major users of natural resources, and are a cause of much pollution in the environment. Public expectations of what particular companies should or should not be doing may become quite strong, and in some cases a company may come under severe criticism from protest groups. The government has an interest in how companies behave, and this is evidenced by the wide-ranging regulations and laws that are impose on businesses, including environment regulations, health and safety regulations, employment regulations and so on.

For each company, some stakeholders are likely to be more influential than others. However, when there are several influential stakeholder groups the company may need to take their conflicting interests into consideration, and set their objectives and performance targets accordingly.

1.3 Market conditions

Market conditions are any factors that influence the state of the market or markets in which a company operates. These include:

- the state of the economy
- innovation and technological change.

Companies will usually hope to achieve growth in sales and profits, and economic conditions may be either favourable or adverse. When the economy is growing, demand for goods and services generally should be increasing, and market conditions are favourable for the development and growth of business. When the economy is in recession, the opposite is true: companies may even struggle to survive.

Other financial conditions may affect a company's performance, such as changes in rates of taxation, interest rates or foreign exchange rates.

1.4 Allowance for competitors

The targets that a company sets, and the performance that it achieves, are also affected the by nature of competition in the market. When the size of a market is fixed, and competition is strong, the rival firms will compete for market share.

The performance of a company in a competitive market may be measured by the size of market share that it obtains. This aspect of performance was described in the earlier chapter on market size and market share variances.

The performance of a company may also be affected by the actions taken by competitors. For example if a major competitor has reduced its sales prices, a company may feel obliged to respond by cutting its own prices. Although there may be some increase in sales from the price reductions, the net result is likely to be a reduction in profits.

For the purpose of your examination, it is therefore necessary to understand that when you assess the performance of a company, it is useful to:

- make comparisons with the performance of rival companies and
- consider whether the performance of a company has been affected by activities of competitors.

1.5 Allowing for external considerations

Allowance should be made for external considerations in performance management in three ways:

- In some cases, it may be appropriate to **alter objectives** to allow for external considerations. In particular, the objectives of a company should make some allowance for the conflicting interests of different stakeholder groups.
- **Performance targets should be set** by making assumptions about external factors such as the state of the economy and probable size of the market. The

targets for growth may depend on whether the economy is expected to grow strongly, grow slowly or decline.

- **Actual performance should be assessed** by taking into consideration unexpected developments in the external environment. As mentioned earlier, failure to achieve targets for sales revenue may be the result of unexpected initiatives by a major competitor.

Interpretation of performance in the light of external considerations

When you answer an examination question on performance measurement, remember the expectations of the examiner.

- Calculate suitable measures of performance.
- Make an assessment of the performance. Does it appear to be good or bad? Is it better or worse than the performance target or budget?
- Use the background information provided in the question and look for something that might explain the bad or good performance, and use this information to express an opinion.

Behavioural aspects of performance reporting: reward systems

- Unintended consequences of performance measurement systems
- Performance rewards
- Designing reward schemes: factors to consider
- Behavioural problems with reward systems
- Performance and participation in target-setting
- Budget slack

2 Behavioural aspects of performance reporting: reward systems

2.1 Unintended consequences of performance measurement systems

An aim of performance reporting systems should be to improve performance. In order to achieve this objective, it is often necessary to consider the behavioural implications of performance reports.

Performance reports should be used in the way intended. In practice, however, there may be unintended consequences, particularly when managers receive rewards for good performance.

Performance measurement systems can suffer from several problems that reduce their effectiveness.

- **Tunnel vision**. Managers may focus on achieving performance targets to the exclusion of other aspects of management. When there is a narrow focus on performance, there is a risk that managers will make decisions that improve performance in the short term, even if they could be damaging in the long term. For example an office manager may decide to leave unfilled some job vacancies in the office, in order to keep labour costs down and meet the expenditure budget for the office. The shortage of staff may, however, reduce the efficiency and effectiveness of the office activities.
- **Sub-optimisation**. Sub-optimisation occurs when managers focus on achieving good performance in one area, but in doing so overlook other aspects of performance. As a result, overall performance is not as good as it should be. For example, management may be given performance targets for the sales of new products: they may focus on sales growth for new products, and in doing so overlook the need to maintain sales of established products. As a result total sales and profits might fall.
- **Myopia**. Myopia is short-sightedness. In the context of performance measurement, it means concentrating on short-term performance measures to the exclusion of longer-term considerations.
- **Measure fixation**. Measure fixation means taking action to ensure that specific performance targets are reached without considering the possible consequences. For example, a department might have a target for labour costs as a maximum

proportion of its total operating costs. In order to meet this target, management might recruit and employ inexperienced and untrained staff who are paid less money than experienced employees. The labour cost target may be met, but the quality of work may deteriorate.

- **Misrepresentation**. Misrepresentation describes the tendency to give a false but flattering picture of performance, by disguising actual results. For example, a sales manager might represent the sales performance for a period in a flattering light – with some growth in sales volume. However, this could be misleading. The sales volume growth might have been achieved only as a result of heavy price discounting and a big reduction in gross profit margins.
- **Misinterpretation**. Misinterpretation occurs when performance measures are interpreted in an incorrect or over-simplified way. Management might read something good or something bad in a set of performance figures, when the actual situation is more complex and the results are not so easy to interpret.
- **Gaming**. Gaming occurs when there is a deliberate distortion of a performance measure or a performance target, in order to make actual results subsequently appear much better than they really are. For example, a departmental manager might argue that productivity in the department has been poor, so that a low performance target is set for productivity in the department. If the target is set at a low level, it is relatively easy to achieve, and the department's performance will therefore appear better than it really is.
- **Ossification**. Performance measurement systems should be flexible, and new performance measures should be introduced as appropriate to replace measures that are no longer appropriate. Ossification refers to an unwillingness that may exist to change any parts of the measurement system, after it has been introduced. It therefore demonstrates a lack of flexibility in performance management.
- **Lack of consistency**. Within an organisation, the performance targets set for individuals or groups may be inconsistent with each other. For example, a production manager may be given performance targets relating to keeping costs under control, and a quality control manager may have performance targets for ensuring the quality of completed output. The targets of the production manager and the quality control manager may be inconsistent, if lower costs are achievable by reducing quality.

These problems need to be recognised and understood. Management should continually review the performance measurement system and the appropriateness of the performance targets and performance measurements that are used.

2.2 Performance rewards

Many organisations have systems for linking the achievement of performance targets with rewards for the successful individual. Rewards may take the form of higher pay (for example, a cash bonus or a higher salary) or promotion. Individuals may also feel rewarded by a sense of personal achievement (and possibly also by a formal recognition of their achievement by senior management). In some cases, there may be systems of 'punishment' for poor performance, such as withholding a bonus or even dismissal.

Advantages of reward systems

There are several advantages in having a system of rewards linked to performance:

- A well-designed reward scheme should link rewards to performance that supports strategic objectives. This should help the organisation to implement its strategies and achieve its strategic objectives.
- Rewards can motivate individuals to achieve their performance targets. They can also help to attract and retain talented individuals.
- The payment of rewards for achieving key targets helps to inform managers and employees about what the critical aspects of performance are.
- An effective reward system will encourage employees to focus on continuous improvement.
- Where rewards involve granting shares or share options in the company, employees who benefit from the rewards may be encouraged to think more about the long-term prospects of their company and its market value.

2.3 Designing reward schemes: factors to consider

There are several factors to consider and questions to answer when designing a reward scheme.

- Should the rewards for performance be based on results (outputs) or on the effort that has been put in? A reward scheme for salesmen, for example, can be based fairly simply on results achieved (volume of sales). It is often much more difficult however to reward administrative staff for results achieved, because the results of their efforts might not be easily quantifiable, or measured against clear targets.
- Should rewards be given in a money form (a bonus or higher salary) or in non-monetary form (such as share options)?
- Should rewards be explicit or implicit? Explicit rewards are rewards that will definitely be given for meeting performance targets, such as a cash bonus. Implicit rewards are not specific promises, but there is a general understanding that the rewards will be available for good performance. For example, there is often an expectation of promotion or a higher salary for good performance, but these are not explicit promises, only an implicit understanding.
- How large should rewards be?
- Over what time period should performance be measured before rewards are given?
- Should rewards be given for individual performance, or should there be group rewards for team performance?
- Should the rewards involve equity participation – giving shares or share options to individuals?
- What are the tax implications of different reward schemes? Can a reward scheme be devised that limit the tax liabilities of the employees receiving the rewards, without breaching the tax laws?

2.4 Behavioural problems with reward systems

When individuals are rewarded for performance, some potential behavioural problems might occur.

It is often difficult to measure the performance of individuals, and the performance of groups or teams must be measured instead. When group performance is measured, there may be a problem in the following situations:

- Some members of the group or team believe that they have been responsible for the successful performance of the group, whereas other team members have not contributed as much as they should have. These individuals may be angered if rewards are paid to all members of the team, including the undeserving members.
- The reward system provides rewards to some members of a group, but not to others: for example, a departmental manager may be rewarded, but none of the departmental staff.

When performance is rewarded, the individuals affected will be inclined to focus on the measures of performance that set the level of their reward – to the exclusion of all other aspects of performance. This can have unintended consequences.

For example, a sales manager may be rewarded with a bonus for exceeding a sales target. The manager might therefore take measures to ensure that the sales target is achieved, and to do this, the manager might offer attractive terms to customers, such as large price discounts. As a result, the key performance target – sales revenue – might be achieved, but with the consequence that profit margins are much lower than planned.

2.5 Performance and participation in target-setting

You may be familiar already with management theories of motivation. Briefly, there is an argument that managers and other employees should be allowed to participate in setting performance targets for themselves, because if they have been involved in the setting the targets, they will have a stronger motivation to achieve them.

2.6 Budget slack

In contrast, if targets are decided by senior management and subordinates are 'blamed' for failing to achieve them, the opposite situation may occur. Managers may try to blame others for 'poor performance'. Where possible they will also try to increase the size of their expenditure budget, so that it becomes easier to keep within expenditure limits and so achieve the budget targets.

Excessive expenditure allowances within budgeted expenditure limits are sometimes called **budget slack**.

Q&A

Practice questions

Contents

1 HEN

HEN has a single production process, for which the following costs have been estimated for the period ending 31st December Year 7:

	$
Material receipt and inspection costs	31,200
Power costs	39,000
Material handling costs	27,300

HEN makes three products - X, Y and Z. These products are made by the same group of employees, using power drills. The employees are paid $8 per hour.

The following budgeted information has been obtained for the period ending 31st December Year 7:

	Product X	**Product Y**	**Product Z**
Production quantity (units)	2,000	1,500	800
Batches of material	10	5	15
For each unit of product:			
Direct material (metres)	5	6	2.5
Direct material cost ($)	4	3	6
Direct labour (minutes)	24	40	60
Number of power drill operations (per unit)	8	4	5

Overhead costs are currently absorbed into the cost of production units using an absorption rate per direct labour hour. A factory-wide absorption rate is used for work in all the production departments.

An activity based costing investigation has revealed that the cost drivers for the overhead costs are as follows:

- Material receipt and inspection: number of batches of material
- Power: number of power drill operations
- Material handling: quantity of material (metres) handled.

Required

Prepare a summary of the budgeted production cost per unit for each of the products X, Y and Z for the period ending 31 December Year 7:

(a) using the existing method for the absorption of overhead costs, and

(b) using an approach based on activity based costing, and the information available about cost drivers.

2 Lardco

Lardco is a warehousing and distribution company. It receives and stores products from customers, and then re-packs them for distribution as required. There are three customers for whom the service is provided – Customer A, Customer B and Customer C. The products stored and re-packaged for all three customers are similar in nature and size, but some are more fragile than others and break more easily. These have to be packaged more carefully.

Basic budget information has been gathered for the year to 31 December Year 6 and is shown in the following table:

	Products handled
	units
Customer A	30,000
Customer B	45,000
Customer C	25,000
	Costs
	$000
Packaging materials (See note)	1,950
Labour:	
basic pay	350
overtime pay	30
Occupancy costs	500
Administration and management costs	60

Note

Packaging materials are used in re-packing each unit of product for Customer A, Customer B and Customer C in the ratio 1:2:3 respectively. This ratio is linked to the relative fragility of the goods for each customer. It applies to the cost of packaging materials but not to the costs of labour and overhead.

Additional information has been obtained so that unit costs can be prepared for each of the three customers using an activity based costing approach. The additional information for the year to 31 December Year 6 has been estimated as follows:

(1) Labour and overhead costs have been identified as attributable to each of three work centres: receipt and inspection, storage, and packing as follows:

(2)

	Cost allocation proportions		
	Receipt and inspection	**Storage**	**Packing**
	%	%	%
Labour:			
Basic pay	20	10	70
Occupancy cost	20	60	20
Administration cost	40	10	50
Labour: overtime pay	$15,000	$6,250	$8,750

(3) A study has shown that the fragility of different goods affects the receipt and inspection time needed for the products for each customer. Storage required is related to the average size of the basic incoming product units from each customer. The re-packing of goods for distribution is related to the complexity of packaging required by each customer. The relevant requirements per unit of product for each customer have been evaluated as follows:

	Customer A	**Customer B**	**Customer C**
Receipt and inspection (minutes)	6	9	15
Storage (square metres)	0.3	0.3	0.3
Packing (minutes)	36	45	60

Required

(a) Calculate the average cost per unit of packaged products for each customer using each of the following methods:

(i) Ignoring the ABC study, calculate a cost per unit using traditional absorption costing.

(ii) Taking an activity based costing approach, using the information provided.

(b) Suggest ways in which activity based costing might improve product costing and cost control for Lardco.

3 LCC

LCC has total budgeted production overheads for next year of $816,000 and has traditionally absorbed overheads on a machine hour basis. It makes two products, Product V and Product W.

	Product V	**Product W**
Direct material cost per unit	$20	$60
Direct labour cost per unit	$50	$40
Machine time per unit	3 hours	4 hours
Annual production	6,000 units	4,000 units

Required

(a) Calculate the product cost for each of the two products on the assumption the firm continues to absorb overhead costs on a machine hour basis.

(b) The company is considering changing to an activity based costing (ABC) system and has identified the following information:

	Product V	**Product W**
Number of setups	18	32
Number of purchase orders	48	112

Overhead cost analysis	$
Machine-related overhead costs	204,000
Setup related overhead costs	280,000
Purchasing-related overhead costs	332,000
Total production overheads	816,000

You are required to calculate the unit cost for each of the two products on the assumption that the firm changes to an ABC system, using whatever assumptions you consider appropriate.

(c) Suggest how ABC analysis could be useful for measuring performance and improving profitability.

4 Customer profitability

PQR sells a range of five products. Budgeted annual data for sales and costs are as follows:

Product	Selling price	Variable cost	Annual sales
	$	$	Unitd
A	3.60	2.40	100,000
B	2.50	2.00	150,000
C	4.00	2.80	120,000
D	2.40	1.50	180,000
E	6.00	4.00	80,000

The products are sold to four different types or category of customer, as follows:

% of annual sales

	Category of customer			
Product	**C1**	**C2**	**C3**	**C4**
A	10%	20%	20%	50%
B	40%	-	30%	30%
C	10%	20%	10%	60%
D	30%	10%	20%	40%
E	20%	-	20%	60%

Fixed costs

Budgeted total fixed costs for the year are $465,000, analysed as follows:

	$
Delivery costs	250,000
Order processing costs	105,000
Cost of promotion events	30,000
	385,000
Other fixed costs	80,000
	465,000

The company operates an activity based costing system. Relevant budgeted data relating to activities is as follows:

	Category of customer			
	C1	**C2**	**C3**	**C4**
Number of deliveries	40	80	50	100
Number of orders	30	70	50	60
Number of promotion events	0	0	2	10
Average km per delivery	100	200	300	150

The cost drivers for each activity are:

- Delivery: kilometres (km)
- Order processing: number of orders
- Promotion events: number of promotion events
- The other fixed costs are general fixed costs, and are not allocated to activities, products or customers.

Required

Using activity based costing, prepare a statement of budgeted customer profitability, for each category of customer.

5 Backflush

Transactions for the year for AYZ are as follows:

Purchases of raw materials	\$5,000,000
Conversion costs	\$3,000,000
Finished goods manufactured	100,000 units
Sales	98,000 units at \$100 per unit

There was no inventory at the beginning of the year. The cost per unit is \$80, consisting of \$50 per unit for materials and \$30 per unit for conversion costs.

Required

Show the book-keeping entries in the cost accounting system using backflush accounting, with two trigger points.

6 Throughput

A company manufactures two products, product X and product Y, on the same machines. Sales demand for the products exceeds the machine capacity of the company's production department. The potential sales demand in each period is for 8,000 units of Product X and 12,000 units of Product Y. Sales prices cannot be increased due to competition from other firms in the market. The maximum machine capacity in the production department is 32,000 hours in each period.

The following cost and profitability estimates have been prepared:

	Product X	Product Y
	$	$
Sales price	22	27
Direct materials	10	9
Direct labour and variable overhead	6	11
Contribution per unit	6	7
Machine hours per unit	1.5 hours	2 hours

Fixed costs in each period are $90,000.

Required

(a) Using marginal costing principles, calculate the profit-maximising output in each period, and calculate the amount of profit.

(b) Explain how throughput accounting differs from marginal costing in its approach to maximising profit.

(c) Use throughput accounting to calculate the throughput accounting ratio for Product X and for Product Y. You should assume that the direct labour cost and variable overhead cost in your answer to part (a) is fixed in the short term.

(d) Using throughput accounting principles, calculate the profit-maximising output in each period, and calculate the amount of profit.

7 Throughput ratio

Dustco exports cases to Spain. Each pallet of cases costs $2,000 in material costs and are sold for $3,000. Production and sales are limited by a shortage of highly trained quality control inspectors. Only 200 inspection hours are available per week. Every pallet is inspected and an inspection takes 30 minutes.
Other factory costs are $300,000 per week.

Required

Calculate the throughput accounting ratio.

8 Four products

A company makes four products, W, X, Y and Z, using the same single item of direct material in the manufacture of all the products. Budgeted data for the company is as follows:

Product	**W**	**X**	**Y**	**Z**
Annual sales demand (units)	4,000	4,000	6,000	3,000
	$	$	$	$
Direct materials cost	5.0	4.0	8.00	6.00
Direct labour cost	4.0	6.0	3.00	5.00
Variable overhead	1.0	1.5	0.75	1.25

Fixed overhead	8.0	12.0	6.00	10.00
Full cost	18.0	23.5	17.75	22.25
Sales price	50.0	31.5	59.75	54.25
Profit per unit	32.0	8.0	42.00	32.00

Due to restricted supply, only $78,000 of direct materials will be available during the year.

Required

Identify the quantities of production and sales of each product that would maximise annual profit.

9 Limiting factors

(a) Company X manufactures four liquids: A, B, C and D. The selling price and unit cost details for these products are as follows:

	Liquid A	Liquid B	Liquid C	Liquid D
	$ per litre	$ per litre	$ per litre	$ per litre
Selling price	100	110	120	120
Costs:				
Direct materials	24	30	16	21
Direct labour (£6/hour)	18	15	24	27
Direct expenses	0	0	3	0
Variable overhead	12	10	16	18
Fixed overhead (note 1)	24	20	32	36
Total cost per litre	78	75	91	102
Profit per litre	22	35	29	18

Note 1

Fixed overhead is absorbed on the basis of labour hours, based on a budget of 1,600 hours per quarter (three months).

During the next three months the number of direct labour hours is expected to be limited to 1,345 hours. The same labour is used for all products.

The marketing director has identified the maximum demand for each of the four products during the next three months as follows:

Liquid A	200 litres
Liquid B	150 litres
Liquid C	100 litres
Liquid D	120 litres

No inventories are held at the beginning of the period that could be used to satisfy demand in the period.

Required

(i) Determine the number of litres of liquids A, B, C and D to be produced and sold in the next three months in order to maximise profits.

(ii) Calculate the profit that this would yield.

(c) Suppose that a contract has been made before the beginning of the period by Company X and one of its customers, Company Y. Company X has agreed to supply Company Y with supply 20 litres of each A, B, C and D during the three month period.

This sales demand from Company Y is included in the demand levels shown above in part (a) of the question.

Required

(i) Given the contract with Company Y, determine the number of litres of liquids A, B, C and D to be produced and sold in the next three months in order to maximise profits, if the maximum number of labour hours remain 1,345 hours for the period.

(ii) Calculate the profit that this would yield.

10 Shortages

An engineering company has been experiencing problems with restricted availability of resources. The company manufactures a variety of casings. It makes four types of casing. Each casing requires the same bought-in component and some high-grade steel. The standard costs for the four types of casing are as follows:

Casing	**A**	**B**	**C**	**D**
	$	$	$	$
Steel	250	500	190	390
Bought-in component	50	50	50	50
Direct labour	60	60	50	100
Variable production costs	40	50	40	50
Fixed production costs	180	240	150	270
Selling and administration costs	145	225	120	215
Profit	35	55	30	55
Selling price	760	1,180	630	1,130

All the selling and administration costs are fixed and the same single component is used for each of the four products. Direct labour is paid $8 per standard hour and each member of the workforce is capable of producing any of the casings.

The company's main customer has ordered 30 units of Casing A, 20 units of B, 30 units of C and 20 units of D for production and delivery in the next month. Senior management have agreed that this order should be treated as a priority order and that these casings must be manufactured and delivered to the customer next month. This is necessary to maintain the goodwill of the customer. It is estimated that this order represents 10% of the total demand next month for each type of casing.

The company operates a just in time system, and has no inventories of steel, components or finished goods.

Required

If the aim is to maximise profit for the month, establish the production and selling plan for the company next month in each of the following situations:

(a) **Situation 1**. Supplies of steel are limited to $250,000.

(b) **Situation 2**. Only 400 bought-in components are available from suppliers.

(c) **Situation 3**. A labour dispute restricts available productive labour hours in the month to 2,125.

(d) **Situation 4**. A labour dispute restricts available productive labour hours in the month to 2,125; but the manufacture of any quantities of the four casings could be sub-contracted to and outside supplier. The cost of buying the casings externally would $475, $705, $380 and $640 for Casing A, Casing B, Casing C and Casing D respectively. In addition, it should be assumed that the major customer insists that its order is completed by the company itself and the manufacture should not be sub-contracted.

Each of the restrictions on production should be treated independently, as four different situations.

11 Proglin

(a) Proglin is a manufacturing company. It makes and sells two versions of a product, Mark 1 and Mark 2. The two products are made from the same direct materials and by the same direct labour employees.

The following budgeted data has been prepared for next year:

	Mark 1	Mark 2
Direct materials per unit	$2	$4
Direct labour hours per unit	3 hours	2 hours
Maximum sales demand	5,000 units	unlimited
Contribution per unit	$10 per unit	$15 per unit

Direct materials and direct labour will be in restricted supply next year, as follows:

	Maximum available
Direct materials	$24,000
Direct labour hours	18,000 hours

There is no inventory of finished goods at the beginning of the year.

Required

Use the graphical method of linear programming to identify the quantities of Mark 1 and Mark 2 that should be made and sold during the year in order to maximise profit and contribution.

Calculate the amount of contribution that will be earned.

(b) Suppose that the maximum available amount of direct materials next year is $24,001, not $24,000.

Required

(i) Identify the quantities of Mark 1 and Mark 2 that should be made and sold during the year in order to maximise profit and contribution.

(ii) Calculate the amount of contribution that will be earned.

(iii) Compare the total contribution you have calculated in (b) with the total contribution that you calculated in (a), to calculate the shadow price per $1 of direct materials.

12 Price

A company has developed a new product that it wishes to introduce to the market. The cost per unit is expected to be as follows, assuming annual sales of 40,000 units.

Cost per unit	$
Direct materials:	
Material M1 (2 litres at $15)	30
Material M2 (0.5 litres at $8)	4
Direct labour (3 hours at $10)	30
Fixed overheads (3 hours at $12)	36
Full cost	100

It has been company policy to price products to achieve a profit of 16.67% (one-sixth) on the sales price.

Required

(a) Calculate the selling price that would be charged if the company applies its normal pricing policy.

(b) If the company decided to price products at marginal cost plus, what mark-up on the marginal cost would be required to obtain the same selling price as in (a)?

(c) Suggest two other pricing strategies that might be applied to decide a selling price for the product.

13 Marginal

The marketing director of a company selling home entertainment products has estimated that at a sales price of \$250, a new product (the Blaze) will sell 400,000 units in the next year. He also estimates that for every \$10 increase or reduction in price, annual sales will fall or increase by 20,000 units below or above this 400,000 units level.

The production engineer has estimated that the costs of making the Blaze will be a variable cost of \$210 per unit sold and annual fixed costs of \$20 million.

You are given the following formulae:

Price function: $P_q = P_0 - bq$

Total revenue function (TR): $P_0q - bq^2$

Marginal revenue function (MR): $P_0 - 2bq$

where

P_0 = Price at zero units of demand

P_q = Price at q units of demand

b = relationship between price and demand

q = units of annual demand

Required

(i) Calculate the price at which the Blaze should be sold in order to maximise profit for the year.

(ii) Calculate the quantity of units that will be sold in the year, if the marketing director's forecast is correct.

(iii) Calculate the annual profit that will be made from selling the Blaze.

14 MC = MR

A business entity has estimated that it faces the following price/quantity relationship:

Sales price	Quantity demanded
\$	Units
50	1,000
30	2,000
10	3,000

Required

(a) Calculate a formula for the demand curve, assuming that the demand curve can be drawn as a straight line on a graph.

(b) Find the formula for total revenue.

(c) If the marginal cost per unit is \$8, calculate the price at which contribution is maximised.

15 Snapco

Snapco Company makes product SP8 in department C. For the year commencing 1 January Year 7 the following budget has been formulated for department C:

	$000
Direct costs	
Materials	60
Labour	40
	100
Production overheads	100
Full production cost	200
Administrative and marketing overheads	50
Full cost of sale	250
Profit	50
Revenue (see note)	300

Note: This revenue is from budgeted sales of 20,000 units.

Production overheads are absorbed on the basis of 100% of direct costs. However, half of these costs are fixed, and the other half are variable. It is assumed that they vary with the cost of materials.

The administrative and marketing overheads are based on 25% of factory costs and do not vary within wide ranges of activity. A profit margin of 20% is applied to the full cost of sale. This also results in a price that appears to be fair to customers. Halfway through the year to 31 December Year 7, it became clear that actual sales of SP8 would be 25% below budget. At about the same time that this shortfall in sales became evident, a customer asked about buying 5,000 units of a simplified version of product SP8. If Snapco were to produce this simplified model for the customer, the direct material and labour costs would be lower. It is estimated that materials costing $12,000 and direct labour of $8,000 would be required to produce the 5,000 units. As the production could take place within the firm's existing capacity, fixed costs would not be affected.

Required

(a) Calculate the prices that Snapco should quote to the customer for each unit of the simplified product, assuming that the following pricing policies are applied:

(i) Full cost plus pricing, on the current basis.

(ii) A price that would enable the company to achieve its original budgeted profit.

(b) Give your advice on the price that should be quoted to the customer.

15 Bridon

The following costs per unit relate to the production and sale of 20,000 of a product by Bridon Company, for the financial year that has just ended:

	$ per unit
Direct material	30
Direct labour	10
Overheads:	
Variable	10
Fixed	10
	60

It has been estimated that major cost increases will apply to the following year, assuming that production and sales volumes are still 20,000 units.

	Increase
Direct material	20%
Direct labour	5%
Variable overhead	5%
Fixed overhead	10%

It would be possible to substitute a cheaper grade of direct material, allowing the cost of direct materials to be $31.25 per unit. However, a rejection rate of 5% will arise. (There are currently no rejected units.) This would require an additional annual inspection cost of $30,000.

In the past, the selling price has been set using a mark-up of 50% on full cost and a price of $90 per unit was charged in the current year. However, the sales manager has estimated the price/demand relationships as follows:

Price	$80	$84	$88	$90	$92	$96	$100
Demand (000s units)	25	23	21	20	19	17	15

Required

(a) Decide whether the product should use the regular or the cheaper grade of material.

(b) Calculate the price that should be charged for the product to maximise the annual profit, and the profit that should be expected.

17 Materials and relevant costs

A company is considering whether to agree to do a job for a customer. It has sufficient spare capacity to take on this job.

To do the job, three different direct materials will be required, Material X, Material Y and Material Z. Data relating to these materials is as follows:

Material	Quantity needed for the job	Quantity currently held as inventory	Original cost of units currently held as inventory	Current purchase price	Current disposal value
	units	units	$ per unit	$ per unit	$ per unit
X	800	200	20	23	22
Y	600	400	15	19	12
Z	500	300	30	40	20

Material X is regularly used by the company for other work. Material Y is no longer in regular use, and the units currently held as inventory have no alternative use. Material Z is also no longer in regular use, but if the existing inventory of the material is not used for this job, they can be used as a substitute material on a different job, where the contribution would be $25 per unit of Material Z used.

Required

Calculate the total relevant costs of the materials for this job for the customer.

18 Printing leaflets

(a) The manager of a small printing business has received enquires about printing three different types of advertising leaflet, type A, type B and type C. Selling price and cost information for these leaflets is shown below:

Leaflet type:	Type A	Type B	Type C
	$	$	$
Selling price, per 1,000 leaflets	300	660	1,350
Estimate printing costs:			
Variable costs, per 1,000 leaflets	120	210	390
Specific fixed costs per month	7,200	12,000	28,500

In addition to the specific fixed costs, $12,000 per month will be incurred in general fixed costs.

Required

Assuming that fixed orders have been received to print 50,000 of Leaflet A and 50,000 of Leaflet B each month, calculate the quantity of Leaflet C that must be sold to produce an overall profit, for all three leaflets combined, of $5,400 per month.

(b) The printing business now receives an enquiry from a customer about printing 30,000 of a different type of leaflet. The customer is willing to pay $25,000. The variable labour and overhead costs of producing these leaflets would be $80 per 1,000 leaflets.

The leaflets would be printed on a special type of paper. This costs $500 per 1,000 leaflets. However, there are already sufficient quantities of the paper in inventory for 20,000 of the leaflets. This special paper was purchased three months ago for a customer who then cancelled his order. The material has a disposal value of $1,500, but it could also be used to produce 20,000 units of leaflet C. The cost of normal paper for leaflet C is $300 per 1,000 leaflets.

Required

Calculate the relevant costs of making the leaflets for this special order, and indicate by how much profit would increase as a result of undertaking the order.

19 JB

JB is a small specialist manufacturer of electronic components and much of its output is used by the makers of aircraft. One of the small number of aircraft manufacturers has offered a contract to Company JB for the supply of 400 identical components over the next twelve months.

The data relating to the production of **each component** is as follows:

(a) Material requirements:

3 kilograms material M1:	see note 1 below
2 kilograms material P2:	see note 2 below
1 Part No. 678:	see note 3 below

Note 1

Material M1 is in continuous use by the company. 1,000 kilograms are currently held in stock at a carrying amount of $4.70 per kilogram but it is known that future purchases will cost $5.50 per kilogram.

Note 2

1,200 kilograms of material P2 are held in inventory. The original cost of the material was $4.30 per kilogram but as the material has not been required for the last two years it has been written down to $1.50 per kilogram (scrap value). The only foreseeable alternative use is as a substitute for material P4 (in current use) but this would involve further processing costs of $1.60 per kilogram. The current cost of material P4 is $3.60 per kilogram.

Note 3

It is estimated that the Part No. 678 could be bought for $50 each.

(b) Labour requirements

Each component would require five hours of skilled labour and five hours of semi-skilled. An employee possessing the necessary skills is available and is currently paid $5 per hour. A replacement would, however, have to be obtained at a rate of $4 per hour for the work that would otherwise be done by the skilled employee. The current rate for semi-skilled work is $3 per hour and an additional employee could be appointed for this work.

(c) Overhead

JB absorbs overhead by a machine hour rate, currently $20 per hour of which $7 is for variable overhead and $13 for fixed overhead. If this contract is undertaken it is estimated that fixed costs will increase for the duration of the contract by $3,200. Spare machine capacity is available and each component would require four machine hours.

A price of $145 per component has been suggested by the large aircraft manufacturer.

Required

State whether or not the contract should be accepted and support your conclusion with appropriate figures for presentation to management.

20 Product B22

BB Company has received an enquiry from a customer for the supply of 500 units of a new product, product B22. Negotiations on the final price to charge the customer are in progress and the sales manager has asked you to supply relevant cost information.

The following information is available:

(1) Each unit of product B22 requires the following raw materials:

Raw material type

X	4 kg
Y	6 kg

(2) The company has 5,000 kg of material X currently in stock. This was purchased last year at a cost of $7 per kg. If not used to make product B22, this stock of X could either be sold for $7.50 per kg or converted at a cost of $1.50 per kg, so that it could be used as a substitute for another raw material, material Z, which the company requires for other production. The current purchase price per kilogram for materials is $9.50 for material Z and $8.25 per kg for material X.

(3) There are 10,000 kilograms of raw material Y in inventory, valued on a FIFO basis at a total cost of $142,750. Of this current inventory, 3,000 kilograms were purchased six months ago at a cost of $13.75 per kg. The rest of the inventory was purchased last month. Material Y is used regularly in normal production work. Since the last purchase of material Y a month ago, the company has been advised by the supplier that the price per kilogram has been increased by 4%.

(4) Each unit of product B22 requires the following number of labour hours in its manufacture:

Type of labour:

Skilled: 5 hours

Unskilled: 3 hours

Skilled labour is paid $8 per hour and unskilled labour $6 per hour.

(5) There is a shortage of skilled labour, so that if production of B22 goes ahead it will be necessary to transfer skilled workers from other work to undertake it. The other work on which skilled workers are engaged at present is the manufacture of product B16. The selling price and variable cost information for B16 are as follows:

	$/unit	$/unit
Selling price		100
Less: variable costs of production		
Skilled labour (3 hours)	24	
Other variable costs	31	
		55
		45

(6) The company has a surplus of unskilled workers who are paid a fixed wage for a 37-hour week. It is estimated that there are 900 hours of unused unskilled labour time available during the period of the contract. The balance of the unskilled labour requirements could be met by working overtime, which is paid at time and a half.

(7) The company absorbs production overheads by a machine hour rate. This absorption rate is $22.50 per hour, of which $8.75 is for variable overheads and the balance is for fixed overheads. If production of product B22 is undertaken, it is estimated that an extra $4,000 will be spent on fixed costs. Spare machining capacity is available and each unit of B22 will require two hours of machining time in its manufacture using the existing equipment. In addition, special finishing machines will be required for two weeks to complete the B22. These machines will be hired at a cost of $2,650 per week, and there will be no overhead costs associated with their use.

(8) Cash spending of $3,250 has been incurred already on development work for the production of B22. It is estimated that before production of the B22 begins, another $1,750 will have to be spent on development, making a total development cost of $5,000.

Required

Calculate the minimum price that the company should be prepared to accept for the 500 units of product B22. Explain briefly but clearly how each figure in the minimum price calculation has been obtained.

(Note: The minimum price is the price that equals that the total relevant costs of producing the items. Any price in excess of the minimum price will add to total profit).

20 Make or buy

Stamba makes two components, A and B, for which costs in the next year are expected to be as follows:

	A	**B**
Production (units)	30,000	20,000
Variable costs per unit:	$	$
Direct materials	6	5
Direct labour	3	9
Variable production overheads	1	3
Variable production cost	10	17

Direct labour is paid $12 per hour. There will be only 19,500 hours of direct labour time available next year, and any additional components must be purchased from an external supplier.

Total fixed costs per annum are expected to be as follows:

	$
Incurred as a direct consequence of making A	40,000
Incurred as a direct consequence of making B	50,000
Other fixed costs	30,000
	120,000

An external supplier has offered to supply units of A for $12.50 and units of B for $23.

Required

(a) Recommend whether Stamba should shut down internal production of Component A or Component B and switch to external purchasing.

(b) Recommend the quantities that Stamba should make of the components, and the quantities that it should buy externally, in order to obtain the required quantities of both components at the minimum cost. Calculate what the total annual cost will be.

Tutorial note. To answer part (b), you will need to consider that labour is a limiting factor.

22 Villaco

Villaco produces two products with the following costs and revenue per unit:

	Product A	Product B
	$	$
Sales price	20	10
Variable cost	8	6
Fixed cost	4	3
	units	units
Sales demand	2,000	3,000

There are only 7,000 machine hours available, and Product A requires 4 machine hours per unit and Product B requires 1 machine hour per unit

Required

(a) Calculate the profit-maximising production and sales mix.

(b) Assume that all the data is the same, except that we are able to sub-contract the products for an additional variable cost of $1 per unit for A and $0.50 per unit for B.

What is the profit-maximising decision?

23 Payoff table

A baker pays $0.10 for buns and sells them for $0.30. At the end of a day, any pastries that have not been sold must be thrown away. On any particular day, the probability distribution of sales demand is as follows:

Number of pastries demanded by customers	20	40	60
Probability	0.3	0.5	0.2

Required

a) Construct a payoff matrix to show all the possible outcomes

b) How many buns should the baker make if he bases his decision on expected value?

24 Grab

Grab is a company that engages in site clearance and site preparation work. Information about its operations is as follows:

(1) It is Grab's policy to hire all the plant and machinery it needs, rather than to purchase its own plant and machinery.

(2) Grab will enter into an advance hire agreement contract for the coming year at one of three levels – high, medium or low – which correspond to the requirements of a high, medium or low level of orders obtained.

(3) The level of orders obtained will not be known when the advance hire agreement contract is entered into. Probabilities have been estimated by management as to the likelihood of the orders being at a high, medium or low level.

(4) Where the advance hire agreement entered into is lower than that required for the level of orders actually obtained, a premium rate must be paid to obtain the additional plant and machinery required.

(5) No refund is obtainable where the advance hire agreement for plant and machinery is at a level in excess of that required to satisfy the site clearance and preparation orders actually obtained.

A summary of the information relating to the above points is as follows:

Level of orders	**Sales revenue**	**Probability**	**Plant and machinery hire costs**	
			Advance hire	**Conversion premium**
	$000		$000	$000
High	15,000	0.25	2,300	
Medium	8,500	0.45	1,500	
Low	4,000	0.30	1,000	
Low to medium				850
Medium to high				1,300
Low to high				2,150
Variable cost (as a percentage of turnover) 70%				

Required

(a) Prepare a summary which shows the forecast net margin earned by Grab for the coming year for each possible outcome.

(b) On the basis of maximising expected value, advise Grab whether the advance contract for the hire of plant and machinery should be at the low, medium or high level.

(c) Explain how the risk preferences of the management responsible for the choice of advance plant and machinery hire contract may alter the decision reached in (b) above.

25 Zero based budgeting

State briefly where zero-based budgeting is likely to be of the greatest value and suggest how often ZBB should be used.

26 Learning

A company has developed a design for a new product, the Widgette. It intends to sell the product at full production cost plus a profit margin of 40%. The estimated production cost and selling price for the first unit of the Widgette are as follows:

	$
Direct materials	2,000
Direct labour (200 hours at $15 per hour)	3,000
Fixed production overhead ($20 per direct labour hour)	4,000
Full production cost	9,000
Profit margin (40%)	3,600
Selling price	12,600

The company's management expects reductions in the time to produce subsequent units of the Widgette, and an 80% learning curve is expected.

A customer has expressed an interest in buying units of the Widgette, and has asked the following questions:

(1) If we bought the first Widgette for $12,600 and immediately ordered another one, what would be the selling price for the second Widgette?

(2) If we waited until you have sold the first two Widgettes to another customer, and then ordered the third and the fourth units that you produce, what will be the average price for the third and fourth units?

(3) If we decided to buy eight Widgettes immediately, and asked you to quote a single price for all eight units, what price would you charge?

Required

(a) Answer each of these questions, assuming that the policy of the company remains to make a profit margin of 40% on every unit that it makes and sells.

(b) List three limitations of learning curve theory.

27 Greenears

Greenears is a new business producing woollen hats, which it makes in small batches of a standard size. It estimates that the first batch of a new design of hand-made hats will have a labour cost of $2,000. There will be an 85% learning curve effect for subsequent batches.

In month 1 production is 5 batches, and in month 2 production is 7 batches.

Required

Estimate the total labour cost in month 2 for making the hats.

28 Regression

A company has achieved the following total sales in each year for the past five years:

Year	Total sales
	$ million
20X4 = Year 1	12
20X5 = Year 2	15
20X6 = Year 3	15
20X7 = Year 4	18
20X8 = Year 5	19

Required

(a) Use linear regression analysis to establish a formula for the trend line in sales, and use this formula to estimate what total sales should be in Year 6 and Year 7.

(b) Calculate the correlation coefficient to decide how much reliance you can place in your forecasts.

To produce your answer, you can make use of the following calculations:

Year	Total sales			
x	y	xy	x^2	y^2
1	12	12	1	144
2	15	30	4	225
3	15	45	9	225
4	18	72	16	324
5	19	95	25	361
15	79	254	55	1,279

29 Flexed budget

LAW operates a system of flexible budgets and the flexed budgets for expenditure for the first two quarters of Year 3 were as follows:

Flexed budgets - quarters 1 and 2

Activity	Quarter 1	Quarter 2
Sales units	9,000	14,000
Production units	10,000	13,000
Budget cost allowances	$	$
Direct materials	130,000	169,000

Production labour	74,000	81,500
Production overhead	88,000	109,000
Administration overhead	26,000	26,000
Selling and distribution overhead	29,700	36,200
Total budgeted cost	347,700	421,700

The cost structures in quarters 1 and 2 are expected to continue during quarter 3 as follows:

(a) The variable cost elements behave in a linear fashion in direct proportion to volume. However, for production output in excess of 14,000 units, the variable cost per unit for production labour increases by 50%. This is due to a requirement for overtime working. The extra amount is payable only on the production above 14,000 units.

(b) Fixed costs are not affected by changes in activity levels.

(c) The variable elements of production costs are directly related to production volume.

(d) The variable element of selling and distribution overhead is directly related to sales volume.

Required

Prepare a statement of the budgeted cost allowance for quarter 3. The activity levels during quarter 3 were:

	Units
Sales	14,500
Production	15,000

30 Cost estimation

The following recorded monthly costs of production will be used to estimate fixed costs per month and the variable cost per unit:

Output	**Total cost**
000 units	$000
17	63
15	61
12	52
22	74
18	68

Required

(a) Using the high low method, estimate the fixed costs per month and the variable cost per unit. Use your estimate to budget the total costs in a month when output is 15,000 units.

(b) Using linear regression analysis, estimate the fixed costs per month and the variable cost per unit. Use your estimate to budget the total costs in a month when output is 15,000 units.

(c) Calculate the correlation coefficient and comment on what it shows.

31 Time series

Seasonal Sales Company is preparing sales forecasts. It has used historical records of sales in every three months to establish the following trend line for sales and seasonal variations. Sales in each quarter are higher or lower than trend because seasonal factors affect sales demand.

Derived from historical sales data

Quarter	**Trend in quarterly sales**	**Seasonal variation for the quarter**
	$000	$000
3	1,200	– 12
4	1,240	– 20
5	1,281	+ 26
6	1,323	+ 6
7	1,357	– 14
8	1,400	– 17
9	1,435	+ 22
10	1,476	0
11	1,520	– 7
12	1,568	– 17
13	1,604	+ 30
14	1,638	+ 3

The trend line data has been used to establish a forecast trend in quarterly sales. This is (in $000) 1,080 + 40P where P is the period number.

Required: Prepare a sales forecast for quarters 17 – 20, and comment briefly on the reliability of your forecast.

32 Reconcile

A company makes a single product and uses standard absorption costing. The standard cost per unit is as follows:

	$ per unit
Direct materials	8
Direct labour	6
Fixed production overheads	12
	26

Budgeted production is 14,000 units per month. Last month, actual production was 14,800 units, and actual costs were as follows:

Total costs	$
Direct materials	125,000
Direct labour	92,000
Fixed production overheads	170,000
	387,000

Required

Prepare a statement for the month that reconciles budgeted costs, standard costs and actual costs

33 Simple variances

(a) Z Company uses a standard costing system and has the following labour cost standard in relation to one of its products:

4 hours of skilled labour at $6.00 per hour: $24.00

During October, 3,350 units of this products were made, which was 150 units less than budgeted. The labour cost incurred was $79,893 and the number of direct labour hours worked was 13,450.

Required

Calculate the direct labour rate and efficiency variances for the month.

(b) Company J uses a standard costing system and has the following data relating to one of its products:

	$ per unit	$ per unit
Selling price		9.00
Variable cost	4.00	
Fixed cost	3.00	
		7.00
Profit		2.00

The budgeted sales for October Year 5 were 800 units, but the actual sales were 850 units. The revenue earned from these sales was $7,480.

Required

Calculate the sales price and sales volume variances for October using:

- standard absorption costing
- standard marginal costing.

(c) The budget was to produce 15,000 units. The standard fixed production cost of a product is $20, which is 4 hours at a rate of $5 per direct labour hour. Actual production was 14,600 units and actual fixed production overhead expenditure was $325,000. The production output was manufactured in 58,000 hours of work.

Required

Calculate:

- the fixed production overhead total cost variance
- the fixed production overhead expenditure variance and volume variance
- the fixed production overhead efficiency variance and capacity variance

34 Manufacturing cost variance

A manufacturing company uses a standard absorption costing system in accounting for its production costs.

The standard cost of a unit of product is as follows:

	Standard quantity	Standard price/rate	Standard cost
		$	$
Direct materials	5 kilos	6.00	30.00
Direct labour	20 hours	4.00	80.00
Variable production overhead	20 hours	0.20	4.00
Fixed production overhead	20 hours	5.00	100.00

The following data relates to Period 1:

Budgeted output	25,000 units
Actual output - produced	20,000 units
Units sold	15,000 units
Materials put into production	120,000 kilos
Materials purchased	200,000 kilos
Direct labour hours paid	500,000 hrs

Due to a power failure 10,000 hours were lost.

Cost of materials purchased and used	$825,000
Rate per direct labour hour	$5
Variable production overhead	$70,000
Fixed production overhead	$2,100,000

Required

Calculate, for Period 1:

1 the material price variance
2 the material usage variance
3 the direct labour rate variance
4 the direct labour idle time variance
5 the direct labour efficiency variance
6 the variable overhead total cost variance
7 the fixed overhead expenditure variance
8 the fixed overhead volume variance
9 the manufacturing cost variance.

35 Variances and operating statements

Standard data per unit of Product Q is as follows:

	$ per unit	$ per unit
Standard sales price		6.00
Direct labour cost	0.64	
Direct material cost	3.00	
Variable production overheads	0.16	
		3.80
Contribution		2.20
Fixed overheads		0.20
Profit		2.00

The budgeted production and sales volume for Product Q was 12,000 units. Budget for 2,400 direct labour hours (12,000 units):

- 5 units to be produced per hour
- Standard labour cost is $3.20 per hour
- Standard material cost is $1.50 per kilogram and each unit requires 2 kilos
- Budgeted fixed overheads $2,400
- Budgeted variable overhead cost per direct labour hour = $0.80.

Actual results for the same period:

- 11,500 units were manufactured
- 2,320 direct labour hours were worked, and cost $7,540
- 25,000 kilos of direct material were purchased (and used) at a cost of $1.48 per kilogram.
- Inventory is valued at standard cost of production.
- Actual variable overheads were $1,750
- Actual fixed overheads were $2,462
- 10,000 units were sold for $62,600.

Required

Prepare operating statements for the period using:

(a) standard absorption costing and

(b) standard marginal costing.

To prepare the absorption costing operating statement, you should show the variable overhead expenditure and efficiency variances, and the fixed overhead expenditure and volume variances.

36 Standard costing

A manufacturing company produces a single product, the Sigma. The standard cost card for Sigma is as follows:

Standard cost card	**$**
Direcxt materials:	
2 kilos of A at $2 per kilo	4.00
1 kilo of B at $6 per kilo	6.00
Direct labour:	
3 hours at $6 per hour	18.00
Overheads:	
Variable - 3 hours at $4 per direct labour hour	12.00
Fixed - 3 hours at $8 per direct labour hour	24.00
Total standard cost	64.00
Standard profit mark-up (25%)	16.00
Standard selling price	80.00

The company planned to produce 10,000 units of Sigma in the month of April (budgeted fixed overheads for the month being $240,000).

The actual results for April are as follows:

	$
Sales: 9,000 units	756,000
Direct materials:	
A: 19,000 kilos	41,800
B: 10,100 kilos	56,560
Direct labour: 28,500 hours	182,400
Variable overheads	104,000
Fixed overheads	232,000
	616,760
Profit	139,240

Manufacturing overheads are charged to production on the basis of direct labour hours. Actual production for the period was 9,000 units.

Required

(a) Prepare a reconciliation of budget and actual profit for the month.

(b) Explain how this would differ using standard marginal costing.

37 Sales variances

A company makes and sells three products Q, R and S. During a period, budgeted and actual results were as follows:

Budget

Product	Total sales revenue	Sales volume	Price	Margin	Total margin
	$	units	$	$	$
Q	18,000	600	30	10	6,000
R	16,500	300	45	15	4,500
S	6,500	100	65	25	2,500

Actual

Product	Total sales revenue	Sales volume	Price	Margin	Total margin
	$	units	$	$	$
Q	14,560	520	28	8	4,160
R	14,210	290	49	19	5,510
S	5,670	90	63	23	2,070

Required

Calculate all relevant sales margin variances.

38 Mix and yield variances

A chemical company has the following standard cost for producing 9 litres of a lubricant:

- 5 litres of material P at $0.70 per litre
- 5 litres of material Q at $0.92 per litre.

There are no inventories of materials, and all material price variances relate to materials used. Actual results showed that 100,000 litres of materials were used during a particular period as follows:

- 45,000 litres of material P: cost $36,000
- 55,000 litres of material Q: cost $53,350

During the period 92,070 litres of the lubricant were produced.

Required

Calculate the total materials cost variance and analyse it into its price, usage, yield and mix components.

39 More mix and yield

The standard cost for a product, product Z, includes the following direct materials costs:

		$ per unit
Material X	5 kilos at $8 per kilo	40
Material Y	3 kilos at $12 per kilo	36
		76

The materials can be mixed in differing proportions.

Actual production during April was 1,250 units of Product Z, with the following direct materials costs:

		$
Material X	6,700 kilos	51,400
Material Y	2,900 kilos	39,500
		90,900

Required

(a) Calculate the direct materials price, mix and yield variances for the month.

(b) Reconcile the actual and standard direct materials costs for the month.

40 Planning and operational variances

CAD manufactures product X. In the annual budget for the current year, the standard direct labour cost for Product X is:

3 hours per unit × \$15 per hour = \$45 per unit.

This cost was based on the expectation that new working procedures and new equipment would be used to reduce the labour time per unit. The changes have not yet been introduced, however, in retrospect, it is decided that a more appropriate direct labour cost for product X should be:

4 hours per unit × \$15 per hour = \$60 per unit.

In the current period, 2,000 units of Product X were produced. These took 8,200 hours to make, and the direct labour cost was \$120,800.

Required

(a) Reconcile the actual direct labour costs to the original standard costs, using planning and operational variances.

(b) Show the planning and operational variances if 2,000 units were made in the period in 8,200 hours at a direct labour cost of \$101,600, and it was decided in retrospect that the appropriate direct labour cost for product X should be:

4 hours per unit × \$12 per hour = \$48 per unit.

41 Size and share

The budgeted and actual annual sales of Pushing Company, and the budgeted and actual variable cost of sale per unit, were as follows.

	Budget			**Actual results**	
Sales volume	**Sales price**	**Variable cost**	**Sales volume**	**Sales price**	**Variable cost**
units	\$ per unit	\$ per unit	units	\$ per unit	\$ per unit
120,000	\$10	\$4	114,000	\$10.50	\$4

The budget was based on an estimate of 600,000 units for the total market size. At the end of the year it was established that the actual total market size was 550,000 units.

Required:
Calculate the sales price variance, market size variance and market share variance, and comment on the sales performance of the company.

42 Learning curve variance

The annual budget of Scullco includes a plan to manufacture six units of a new product that it has not made before. The estimated direct costs of the first unit are as follows:

Expected direct costs of first unit	$	$
Direct materials		14,000
Direct labour		30,000
Other direct costs:		
Related to labour time	2,000	
Not related to labour time	3,000	
		5,000
		49,000

During the year the company actually made 7 units of the product. The costs of the first unit were exactly as budgeted, and total direct costs for the 7 units were:

Actual direct costs of first 7 units	$
Direct materials	95,000
Direct labour	160,000
Other direct costs:	29,400
	284,400

The company expects an 85% leaning curve to apply to the manufacture of this product.

During the year there were no labour rate variances.

Required
Calculate the cost variances for this product and comment briefly on the problems with variance analysis when a learning curve is expected to apply.

43 Balanced

A balanced scorecard approach may be used to set performance targets and monitor performance.

(a) List the four aspects of performance in a balanced scorecard approach.

(b) Suggest how a professional football club might use a balanced scorecard approach. Indicate what key aspects of performance might be identified and suggest performance targets that a football club might use in a balanced scorecard approach.

44 Pyramid

(a) Describe briefly the performance pyramid.

(b) List the dimensions of performance for a service industry, as suggested by Fitzgerald and others.

45 Three services

A company provides three types of delivery service to customers: service A, service B and service C. Customers are a mix of firms with a contract for service with the company, and non-contract customers.
The following information relates to performance in the year to 31st December Year 1:

	Service A	Service B	Service C
Number of deliveries made	350,000	250,000	20,000
% of deliveries to contract customers	60%	60%	80%
Price charged per delivery:			
Contract customers	$9	$15	$300
Premium for non-contract customers	+ 30%	+ 50%	+ 20%

The premium for non-contract customers is in addition to the rate charged to contract customers.

All employees in the company were paid $45,000 per year and sundry operating costs, excluding salaries and fuel costs, were $4,000,000 for the year.

The following operational data for the year relates to deliveries:

	Services A and B	Service C
Average kilometres per vehicle/day	400	600
Number of vehicles	50	18
Operating days in the year	300	300

For Year 2, the company has agreed a fixed price contract for fuel. As a result of this contract, fuel prices will be:

(a) $0.40 per kilometre for Services A and B

(b) $0.80 per kilometre for Service C.

Sales prices will be 3% higher in Year 2 than in Year 1, and salaries and operational expenses will be 5% higher. Sales volume will be exactly the same as in Year 1.

The number of employees will also be the same as in Year 1: 60 employees working full-time on Services A and B and 25 employees working full-time on Service C.

Required

(a) Prepare a budgeted income statement for the year to 31 December Year 2.
(b) Comment on vehicle utilisation.

46 Private medical practice

A private medical practice has five full-time doctors, five full-time assistants and two administrators.

Each doctor treats 18 patients each day on average. The medical centre is open for five days each week, 46 weeks each year.

Charges for patients vary according to the age of the patient and the nature of the treatment provided.

Charges	**Adults below 65 year of age**	**Children and individuals aged 65 years old and over**
	$	$
No treatment: consultation only	50	30
Minor treatment	200	120
Major treatment	600	280

The patient mix and the treatment mix are as follows:

Patients:		**Treatment**	
Adults	45%	No treatment	20%
Children	25%	Minor treatment	70%
Over 65 years old	30%	Major treatment	10%

The salary of each doctor is $240,000, assistants earn $100,000 and administrators earn $80,000. In addition, everyone receives a 5% bonus at the end of the year.

The medical practice expects to pay $414,300 for materials next year and other (fixed) costs will be $733,600.

Required

Using the information provided, present an income statement for the medical practice for next year. (Ignore the effects of inflation.)

47 Train times

A railway company has two operating divisions, Northern Region and Southern Region. Each division runs inter-city train services and suburban ('commuter') train services. Performance figures for the most recent reporting period are as follows:

	Northern Region		Southern Region	
	Inter-city services	**Suburban services**	**Inter-city services**	**Suburban services**
Journeys	1,500	34,000	1,800	42,000
Completed on schedule	1,240	25,100	1,590	38,600
Completed within 5 minutes of schedule	1,350	29,500	1,690	40,300
Completed within 10 minutes of schedule	1,440	33,100	1,730	41,500
Cancelled journeys	16	405	2	220
Target for on-time completion of journeys	90%	95%	90%	95%

The chief executive officer of the railway company is trying to improve standards of service, and targets have been set for the number of train journeys that should end with the train arriving at its destination on schedule. It is his intention to raise the standards still further in the future.

Required

Assess the service performance of the two regions

48 Growth objective

A company has an objective in its long-term business plan of achieving significant growth in its business in the period Year 1 to Year 5. It is now the end of Year 2.

Its results for the years to 31 December Year 1 and Year 2 are summarised below.

Income statement for the year ended 31 December

	Year 2	**Year 1**
	$	$
Sales	31,200,000	26,000,000
Cost of sales	18,720,000	15,600,000
	12,480,000	10,400,000
Operating expenses	6,780,000	5,200,000
Interest charges	500,000	0
Depreciation	3,000,000	3,000,000
Net profit	2,200,000	2,200,000

Statement of financial position as at 31 December

	Year 2	Year 1
	$	$
Non-current assets	27,300,000	26,000,000
Net current assets	15,600,000	7,800,000
	42,900,000	33,800,000
Loan	9,000,000	0
	33,900,000	33,800,000
Share capital	19,500,000	19,500,000
Accumulated profit	14,400,000	14,300,000
	33,900,000	33,800,000

Sales are seasonal, and are much higher in the first six months of the year than in the second six months. The half-yearly sales figures in the past two years have been as follows:

Sales

	Year 2	Year 1
	$	$
1 January – 30 June	21,645,000	16,900,000
1 July – 31 December	9,555,000	9,100,000
	31,200,000	26,000,000

The company employs part-time workers during the first six-months of each year. Part-time workers operate for a full working week during the weeks that they are employed. Employee numbers have been as follows:

Employee numbers

	Year 2	Year 1
Full time employees	318	260
Part time (seasonal) employees	494	310

The company introduced four new products to the market in Year 1 and another five new products in Year 2.

Required

Explain with reasons whether the company appears to be on course for achieving its objective of growing the business.

In particular, you should consider growth in sales, profits, investment and product range.

49 Responsibility

A multinational company established a new operating division in Fenland four years ago. The operating division has been established as a profit centre. Decisions relating to the purchase of capital equipment for the division, and borrowing to finance the capital, have been taken at head office.

The results for the first four years of operation have been as follows:

	Year 1	Year 2	Year 3	Year 4
	$000	$000	$000	$000
Sales revenue	172	646	810	1,792
Operating costs	167	620	718	1,490
Depreciation	25	104	187	530
Interest charges	0	132	240	462
Profit/(loss)	(20)	(210)	(335)	(690)

The managing director of the division has been asked to explain its poor performance and the escalating losses. In response, the managing director has argued that the performance of the division has improved, and is not getting worse.

Required

(a) Identify a measure of performance that would suggest that the performance of the division has been improving over the four-year period.

(b) Suggest how the performance of the division should be assessed, and state whether you agree or disagree with the view of the managing director that performance has improved.

50 Cross Streets Hotel

Cross Streets Hotel owns five hotels in the same country, providing accommodation mainly to business people and tourists. Each hotel has a bar and restaurant open to residents and non-residents.

The directors of the company work in two offices in the oldest hotel in the southern region of the country, where the small finance office is also located. Until now the company has only produced statutory financial accounts, and has not produced management accounts.

The directors disagree with each other about the profitability of each of the individual hotels owned and operated by the company. The head of the finance office has proposed that performance reports should be produced, based on a system of responsibility accounting for each of the hotels. The performance of all five hotels should also be amalgamated to prepare performance reports at company level.

Required

Suggest:

- what reports this management information system should produce
- what information the reports should contain

51 Non-financial performance measurements

Suggest **three** non-financial measures of performance that might be helpful to management in assessing the following aspects of operations in a commercial bank:

(1) service quality

(2) marketing effectiveness

(3) personnel

52 Decentralisation

(a) Define the following concepts:

(i) Responsibility accounting

(ii) An investment centre

(iii) Return on investment (for a division)

(iv) Residual income (for a division).

(b) The following information available about Divisions M and W, which are investment centres in LK Group:

	Division M	**Division W**
Divisional investment	\$200,000	\$5,000,000
Division profit	\$20,000	\$410,000

The cost of capital for LK Group is 8%.

Ignore taxation.

Required

(a) Evaluate the performance of Division M and Division W.

(b) Re-evaluate the situation given that the cost of capital is

(1) 6%

(2) 10%.

53 ROI

A company is planning to open a new investment centre, which wil make and sell a single product. The investment in the new division at the beginning of the year will be \$2 million, consisting entirely of non-current assets. These are expected to have a five-year life with no residual value, and they will be depreciated each year at the rate of 20% of cost.

Sales in the first year of operation are expected to be \$4 million and the budgeted gross profit is 30%. Overhead costs excluding depreciation of non-current assets will be \$600,000 in Year 1.

The estimates for the first five years of operation are as follows.

(1) The company will not make any additional investment in non-current assets for the division in the first five years.

(2) The cost of sales per unit in the five years will remain constant, with no increases.

(3) Sales volume will be the same in Year 2 as in Year 1. Sales volume will then increase in Year 3 by 5% but will fall by 10% in Year 4 and a further 10% in Year 5.

(4) The sales price per unit will be increased by 5% in Year 2. There will be no change in sales prices in Year 3, but prices will be increased by 5% in Year 4 and again by 5% in Year 5.

(5) Overhead costs excluding depreciation will remain at $600,000 for the first three years, but will then be $700,000 in each of Years 4 and 5.

Required

Calculate the return on investment for the division for each of the first five years, assuming that ROI is calculated using the net book value of assets at the beginning of the year.

Using ROI and any other measures of performance, assess the expected performance of the division over the five-year period.

54 West Division

Large Group has several separate divisions, each operating as an investment centre within the group. West Division makes and sells three products, A, B and C. All three products are sold under the Titan brand label, but Product A and Product B are also sold through a supermarket group as unbranded products.

Budgeted data for the year to 31 December Year 7 is as follows:

Product sales

	Product A	Product B	Product C
	units	units	units
Titan brand	160,000	120,000	50,000
Unbranded	450,000	600,000	-

Selling prices

	Product A	Product B	Product C
	$ per unit	$ per unit	$ per unit
Titan brand	2.50	3.20	5.00
Unbranded	1.50	2.00	-

Variable costs

	Production	Packaging
	$ per unit	$ per unit
Product A:		
Titan brand	1.20	0.30
Unbranded	1.20	0.10
Product B:		

Titan brand	1.60	0.40
Unbranded	1.60	0.20
Product C:		
Titan brand	2.50	0.50

Budgeted marketing expenditure is $180,000 for the year, and other budgeted expenditure for other fixed costs is $375,000. The average capital employed in West Division in Year 7 is expected to be $400,000 and the division's cost of capital is 10%.

Required

(a) Calculate the budgeted ROI for West Division for the year to 31 December Year 7.

(b) Calculate the budgeted residual income for West Division for the year to 31 December Year 7.

55 Residual

A company is organised into several investment centres. The annual performance of each investment centre is measured on the basis of ROI. ROI is measured each year as the profit before interest as a percentage of the average investment/average capital employed in the investment centre.

One of the investment centres has achieved a ROI in excess of 35% in each of the past four years. Its managers are considering a new investment project that will have the following cash flows:

Year	Cash flow
	$
Beginning of Year 1	(42,000)
1 – 3	19,000 each year

The initial investment will be in an item of machinery that will have no residual value at the end of Year 3. Assume that depreciation is charged on a straight-line basis.

Required

(a) Calculate the ROI for the project, each year and on average for the three-year period.

(b) Suggest whether the managers of the investment centre are likely to invest in the project.

(c) Calculate the residual income for the project, assuming that a cost of capital of 12% is applied. Suggest how the decision by the centre's managers about investing in the project might be changed if residual income rather than ROI were used to measure divisional performance.

56 Two divisions

A company has two operating divisions, X and Y, that are treated as profit centres for the purpose of performance reporting.

Division X makes two products, Product A and Product B. Product A is sold to external customers for $62 per unit. Product B is a part-finished item that is sold only to Division Y.

Division Y can obtain the part-finished item from either Division X or from an external supplier. The external supplier charges a price of $55 per unit.

The production capacity of Division X is measured in total units of output, Products A and B. Each unit requires the same direct labour time. The costs of production in Division X are as follows:

	Product A	Product B
	$	$
Variable cost	46	48
Fixed cost	19	19
Full cost	65	67

Required

You have been asked to recommend the optimal transfer price, or range of transfer prices, for Product B.

(a) What is an optimal transfer price?

(b) What would be the optimal transfer price for Product B if there is spare production capacity in Division X?

(c) What would be the optimal transfer price for Product B if Division X is operating at full capacity due to a limited availability of direct labour, and there is unsatisfied external demand for Product A?

57 Training company

A UK training company has two training centres, one in London and one in Liverpool, each treated as a profit centre for the purpose of transfer pricing.

Each training centre hires its training staff to client organisations, and charges a fixed rate for each 'trainer day'. Trainers are either full-time staff of the company, or are hired externally. Externally-hired trainers are all vetted for quality, and are used when client demand for training exceeds the ability of the division to meet from its full-time staff.

The London centre is very busy and charges its client £2,000 per trainer day. It pays £1,200 per day to external trainers. The variable cost of using its own full-time trainers is £200 per day.

The other training centre is in Liverpool. The manager of the Liverpool centre is meeting with the manager of the London centre to discuss the possibility of the London centre using trainers from the Liverpool centre instead of external trainers. They have agreed this arrangement in principle, but need to agree a daily fee that the London centre should pay the Liverpool centre for these of its trainers.

It has been estimated that if trainers from the Liverpool centre are used in London, the variable costs incurred will be £200 per day, plus £250 per day for travel and accommodation costs. These costs will be paid by the Liverpool centre.

Required

Identify the optimal charge per day for the use of Liverpool trainers by the London training centre, in each of the following circumstances:

(a) assuming that the Liverpool centre has spare consulting capacity

(b) assuming that the Liverpool training centre is fully occupied charging clients £750 per trainer day

(c) assuming that the Liverpool training centre is fully occupied charging clients £1,100 per trainer day.

58 Shadow price

Division A supplies a special chemical to Division B, another profit centre in the same group. The output capacity for making the special chemical in Division A is limited.

- The variable cost of making the chemical is $500 per kilo.
- There is no external intermediate market for the chemical.
- Division B uses the chemical to manufacture a tablet. Each tablet uses ten grams of the chemical.

Sales demand for the tablet exceeds the production capacity of Divisions A and B.

The selling price for each tablet is $10. Further variable processing costs in Division B to make the tablet from the special chemical are $2 per tablet.

Required

(a) Calculate the shadow price of each kilo of the special chemical. (The shadow price of the special chemical is the amount by which total contribution would be reduced (or increased) if one unit less (or more) of the chemical were available.)

(b) Identify the ideal transfer price.

(c) Suggest whether this transfer price will provide a suitable basis for performance evaluation of the two divisions.

59 Bricks

ABC Company is organised into two trading groups. Group X makes materials that are used to manufacture special bricks. It transfers some of these materials to Group Y and sells some of the materials externally to other brick manufacturers. Group Y makes special bricks from the materials and sells them to traders in building materials.

The production capacity of Group X is 2,000 tonnes per month. At present, sales are limited to 1,000 tonnes to external customers and 600 tonnes to Group Y.

The transfer price was agreed at $200 per tonne in line with the external sales trade price at 1st July which was the beginning of the budget year. From 1st December, however, strong competition in the market has reduced the market price for the materials to $180 per tonne.

The manager of Group Y is now saying that the transfer price for the materials from Group X should be the same as for external customers. The manager of Group X rejects this argument on the basis that the original budget established the transfer price for the entire financial year.

From each tonne of materials, Group Y produces 1,000 bricks, which it sells at $0.40 per brick. It would sell a further 400,000 bricks if the price were reduced to $0.32 per brick.

Other data relevant are given below.

	Group X	**Group Y**
	$	$
Variable cost per tonne	70	60
Fixed cost per month	100,000	40,000

The variable costs of Group Y exclude the transfer price of materials from Group X.

Required

(a) Prepare estimated profit statements for the month of December for each group and for ABC Company as a whole, based on transfer prices of $200 per tonne and of $180 per tonne, when producing at

(i) 80% capacity

(ii) 100% capacity, on the assumption that Group Y reduces the selling price to $0.32.

(b) Comment on the effect that might result from a change in the transfer price from $200 to $180.

(c) Suggest an alternative transfer price that would provide an incentive for Division Y to reduce the selling price and increase sales by 40,000 bricks a month.

Q&A

Answers

Contents

1 HEN

(a) Current full costing method

Budgeted hours	hours
Product X: (2,000 × 24/60)	800
Product Y: (1,500 × 40/60)	1,000
Product Z: (800 × 60/60)	800
	2,600

Overhead recovery rate using the current absorption costing method:

$$\frac{\text{Total overheads}}{\text{Total hours}} = \frac{\$\,(31,200 + 39,000 + 27,300)}{2,600}$$

= $37.50.

Full cost per unit (current method)

	Product X		Product Y		Product Z	
		$		$		$
Direct materials		4.00		3.00		6.00
Direct labour	($8 × 24/60)	3.20	($8 × 40/60)	5.33	($8 × 60/60)	8.00
Overheads	($37.50 × 24/60)	15.00	($37.50 × 40/60)	25.00	($37.50 × 60/60)	37.50
		22.20		33.33		51.50

(b) ABC method

Materials receipt and inspection costs:

Cost driver = Number of batches of material

Total number of batches = (10 + 5 +15) = 30

Overhead cost per batch = $31,200/30 batches = $1,040 per batch

Power costs:

Cost Driver = Number of power drill operations

Total number of drill operations

= (2,000 × 8) + (1,500 ×4) + (800 × 5) = 26,000

Overhead cost per drill operation = $39,000/26,000 = $1.50.

Materials handling costs:

Cost driver = Quantity of materials handled

Number of metres handled = (2,000 × 5) + (1,500 × 6) + (800 × 2.5) = 21,000
Overhead costs per metre handled = $27,300/21,000 = $1.30.

Overhead costs

		Product X		**Product Y**		**Product Z**
		$		$		$
Materials receipt	($1,040 × 10)	10,400	($1,040 × 5)	5,200	($1,040 × 15)	15,600
Power	($1.50 × 2,000 × 8)	24,000	($1.50 × 1,500 × 4)	9,000	($1.50 × 800 × 5)	6,000
Materials handling	($1.30 × 2,000 × 5)	13,000	($1.30 × 1,500 × 6)	11,700	($1.30 × 800 × 2.5)	2,600
		47,400		25,900		24,200
Number of units produced		2,000		1,500		800
Overhead cost per unit		$23.7		$17.27		$30.25

Cost per unit (ABC method)

	Product X	**Product Y**	**Product Z**
	$	**$**	**$**
Direct materials	4.00	3.00	6.00
Direct labour	3.20	5.33	8.00
Overheads	22.35	17.27	30.25
	29.55	25.60	44.25

2 Lardco

(a) (i) Budgeted cost: traditional absorption costing

It is assumed that the weighting of 1:2:3 applies to packaging materials, but not to labour and overhead costs.

Packaging material

	Output		**Material usage**	
Customer A	30,000	×	1 =	30,000
Customer B	45,000	×	2 =	90,000
Customer C	25,000	×	3 =	75,000
Weighted units of material				195,000

Therefore, packaging material per weighted unit = $1,950,000/195,000 = $10.

Labour and overheads

Total cost of labour and overheads (000s) = 350 + 30 + 500 + 60 = 940

Total units = (30,000 + 45,000 + 25,000) = 100,000.

Labour and overhead cost per unit = $940,000/100,000 = $9.40.

Budgeted average cost/unit

	Customer A	Customer B	Customer C
	$	$	$
Material	10.0	20.0	30.0
Labour/overhead	9.4	9.4	9.4
Product cost/metre	19.4	29.4	39.4

(ii) Activity based costing analysis of labour and overhead costs

	Receipts and inspection	Storage	Packaging
	$	$	$
Labour			
Basic pay (20:10:70)	70,000	35,000	245,000
Overtime	15,000	6,250	8,750
Occupancy cost (20: 60: 20)	100,000	300,000	100,000
Administration cost (40: 10: 50)	24,000	6,000	30,000
	209,00	347,250	383,750

Activity levels (cost drivers)

Customer	Units		Receipts and inspection (hours)		Storage (metres²)		Packaging (hours)
A	30,000	(× 6/60)	3,000	(× 0.3)	9,000	(× 36/60)	18,000
B	45,000	(× 9/60)	6,750	(× 0.3)	13,500	(× 45/60)	33,750
C	25,000	(× 15/60)	6,250	(× 0.3)	7,500	(× 60/60)	25,000
			16,000		30,000		76,750
Cost			$209,000		$347,250		383,750
Cost/unit of activity			$13.0625 per hour		$11.575 per m²		$5 per hour

ABC-based costs

	Customer A	Customer B	Customer C
	$	$	$
Material	10.00	20.00	30.00
Receipts ($13.0625/hour)	1.31	1.96	3.27
Storage ($11.575/m^2)	3.47	3.47	3.47
Packing ($5/hour)	3.00	3.75	5.00
Product cost/unit	17.78	29.18	41.74

(b) Total costs per unit for Lardco are not much different using activity based costing than they are with traditional absorption costing. However, ABC analysis allows management to look at the costs of overhead-related activities. This may help them to control these costs, through better management of these activities and the resources they use.

3 LCC

(a)

Budgeted machine hours	**hours**
Product V: 6,000 × 3	18,000
Product W: 4,000 × 4	16,000
Total budgeted machine hours	34,000
Budgeted production overheads	$816,000
Absorption rate per machine hour	$24

	Product V	Product W
	$	$
Direct materials	20	60
Direct labour	50	40
Production overhead (3 hours/4 hours × $24)	72	96
Full production cost per unit	142	196

(b) **Machine-related overhead costs:**
Overhead cost per machine hour = $204,000/34,000 hours = $6 per machine hour

Setup related overhead costs:
Overhead cost per set up = $280,000/(18 + 32) = $5,600 per set up.

Purchasing-related overhead costs:
Cost per purchase order = $332,000/ (48 + 112) = $2,075 per order.

Overhead cost analysis		**Product V**			**Product W**	
		Total cost	**Cost/ unit**		**Total cost**	**Cost/ unit**
Overheads:		**$**	**$**		**$**	**$**
Machine-related	(18,000 × 6)	108,000	18.0	(16,000 × 6)	96,000	24.0
Set-up related	(18 × 5,600)	100,800	16.8	(32 × 5,600)	179,200	44.8
Purchasing-related	(48 × 2,075)	99,600	16.6	(112 × 2,075)	232,400	58.1
		308,400	51.4		507,600	126.9

Unit costs	**V**	**W**
	$	$
Direct materials	20.0	60.0
Direct labour	50.0	40.0
Production overhead	51.4	126.9
Full production cost per unit	121.4	226.9

(c) ABC analysis could be used by LCC to analyse the profitability of Products V and W. Using ABC, the overhead cost per unit of W is much higher than with traditional absorption costing, and the cost per unit of V is less. This is because Product W has a relatively large amount of setup activity and purchasing-related activity.

Management could look at the reasons why Product W needs so many setups and purchase orders, and by trying to reduce the resources used up by these activities, it might be possible to reduce the costs (and increase the profitability) of Product W.

4 Customer profitability

Workings

Product	**Units**	**Contribution per unit**	**Total contribution**	**Total sales revenue**
		$	$	$
A	100,000	1.20	120,000	360,000
B	150,000	0.50	75,000	375,000
C	120,000	1.20	144,000	480,000
D	180,000	0.90	162,000	432,000
E	80,000	2.00	160,000	480,000
			661,000	2,127,000

Contribution per customer category

	Total contribution	Category of customer C1	C2	C3	C4
	$	$	$	$	$
Product A	120,000	12,000	24,000	24,000	60,000
Product B	75,000	30,000	0	22,500	22,500
Product C	144,000	14,400	28,800	14,400	86,400
Product D	162,000	48,600	16,200	32,400	64,800
Product E	160,000	32,000	0	32,000	96,000
Total	661,000	137,000	69,000	125,300	329,700

ABC apportionment rates

	Number of deliveries	Km per delivery	Total kilometres
C1	40	100	4,000
C2	80	200	16,000
C3	50	300	15,000
C4	100	150	15,000
			50,000

Apportionment rates

- Delivery costs: $250,000/50,000 = $5 per kilometre
- Order processing: $105,000/(30 + 70 + 50 + 60) = $500 per order
- Promotion events: $30,000/12 = $2,500 per event.

Statement of customer profitability

	C1	C2	C3	C4	Total
	$	$	$	$	$
Contribution	137,000	69,000	125,300	329,700	661,000
Activity costs					
Delivery	(20,000)	(80,000)	(75,000)	(75,000)	(250,000)
Order processing	(15,000)	(35,000)	(25,000)	(30,000)	(105,000)
Promotion events	0	0	(5,000)	(25,000)	(30,000)
Customer profitability	102,000	(46,000)	20,300	199,700	276,000
Other fixed costs					(80,000)
Company profit					196,000

5 Backflush

Backflush accounting, with two trigger points

Raw materials inventory account

		$		$
Creditors		5,000,000	Finished goods inventory	5,000,000

Finished goods inventory account

		$		$
Raw materials	(100,000 × 50)	5,000,000	Income statement (98,000 × 80)	7,840,000
Conversion costs	(100,000 × 30)	3,000,000	Balance c/f (2,000 × 80)	160,000
		8,000,000		8,000,000

Conversion costs account

	$		$
Creditors (overheads)	3,000,000	Finished goods inventory	3,000,000
	3,000,000		3,000,000

Sales

	$		$
Income statement (98,000 × 100)	9,800,000	Receivables (98,000 × 100)	9,800,000

Income statement

	$		$
Finished goods	7,840,000	Sales	9,800,000
Profit	1,960,000		
	9,800,000		9,800,000

6 Throughput

(a) **Marginal costing approach**

Profit will be maximised by producing output to maximise the contribution per machine hour (contribution per unit of limiting factor).

	Product X	**Product Y**
Contribution per unit	\$6	\$7
Machine hours per unit	1.5 hours	2 hours
Contribution per machine hour	\$4	\$3.50
Priority for manufacture	1st	2nd

Profit will be maximised by making and selling 8,000 units of Product X in each period (maximum sales demand). This will require 12,000 machine hours. The remaining 20,000 machine hours should be used to make and sell 10,000 units of Product Y.

	\$
Contribution from Product X: 8,000 × \$6	48,000
Contribution from Product Y: 10,000 × \$7	70,000
Total contribution	118,000
Fixed costs	90,000
Profit	28,000

(b) Throughput accounting is based on the view that value is not added to a product until the product is eventually sold. There is no value in inventory. When there is a limiting factor restricting production, all costs except for the cost of bought-in materials (raw materials, purchased components) are fixed costs in the short-term, including direct labour costs and associated 'variable' overheads.

The aim should be to maximise throughput in a period, where throughput is defined as sales minus the cost of bought-in materials.

The main difference between throughput accounting and marginal costing is in the treatment of direct labour and variable overhead costs as a 'fixed cost' in the short-term. In throughput accounting, fixed costs are referred to as 'factory cost'.

(c) Throughput accounting ratio =

Return per bottleneck unit / Factory cost per bottleneck unit

Here, the bottleneck resource is machine time.

	Product X	Product Y
	$	$
Sales price	22	27
Materials cost	10	9
Throughput	12	18
Machine hours per unit	1.5 hours	2 hours
Throughput/return per machine hour	$8	$9

To calculate the cost per factory hour, we need to make an assumption about direct labour cost and variable overhead costs. It is assumed that the direct labour cost and variable overhead cost in the answer to part (a) is fixed in the short-term.

	$
Direct labour and variable overhead costs:	
Product X: 8,000 × $6	48,000
Product Y: 10,000 × $11	110,000
Total contribution	158,000
Fixed costs	90,000
Factory cost in each period	248,000

Factory cost per machine hour = $248,000/32,000 hours = $7.75.

	Product X	Product Y
Return per machine hour	$8	$9
Factory cost per machine hour	$7.75	$7.75
Machine hours per unit	1.5 hours	2 hours
Throughput accounting ratio	1.03	1.16
Priority for manufacture	2nd	1st

Tutorial note: The aim should be to maximise the throughput accounting ratio, and to ensure that the ratio is higher than 1.0. The throughput accounting ratio for both Product X and Product Y is low, close to the minimum acceptable level.

(d) Profit will be maximised by making and selling 12,000 units of Product Y (maximum sales demand). This will use up 24,000 machine hours. The remaining 8,000 machine hours should be used to make 5,333.33 units of Product X.

	$
Return from Product Y: 12,000 × $18	216,000
Return from Product Y: 5,333.33 × $12	64,000
Total return/throughput	280,000
Fixed costs	248,000
Profit	32,000

7 Throughput ratio

Throughput per pallet = $3,000 – $2,000 = $1,000.

Throughput per inspection hour = $1,000/0.5 hours = $2,000.

Operating expenses per inspection hour = $300,000/200 = $1,500.

Throughput accounting ratio = $2,000/$1,500 = 1.33.

8 Four products

	W	X	Y	Z
	$	$	$	$
Sales price/unit	50.0	31.5	59.75	54.25
Variable cost/unit	10.0	11.5	11.75	12.25
Contribution per unit	40.0	20.0	48.00	42.00
Direct materials per unit ($)	5	4	8	6
Contribution per $1 direct material	£8.0	£5.0	£6.0	£7.0
Priority for making and selling	1st	4th	3rd	2nd

Profit-maximising budget

Product	**Sales units**	**Direct materials**	**Contribution per unit**	**Total contribution**
		$	$	$
W (1st)	4,000	20,000	40	160,000
Z (2nd)	3,000	18,000	42	126,000
Y (3rd) - balance	5,000	40,000	48	240,000
		78,000		526,000

9 Limiting factors

(a)

	A	B	C	D
	$	$	$	$
Sales price	100	110	120	120
Variable cost per litre	54	55	59	66
Contribution per litre	46	55	61	54
Direct labour hours/unit	3	2.5	4	4.5
Contribution /direct labour hour	£15.33	£22	£15.25	£12
Priority for manufacture/sale	2nd	1st	3rd	4th

The fixed overhead absorption rate is $8 per hour. This can be calculated from the overhead cost and direct labour hours for any of the four products.

The budgeted labour hours for calculating this absorption rate was 1,600 hours, therefore budgeted fixed costs are 1,600 hours × $8 = $12,800.

The output and sales that will maximise contribution and profit is as follows:

Product	Litres	Hours	Contribution /litre	Contribution /profit
			$	$
B	150.0	375	55	8,250.0
A	200.0	600	46	9,200.0
C (balance)	92.5	370	61	5,642.5
		1,345		23,092.5
Fixed costs (see above)				12,800.0
Profit				10,292.5

(b) In this situation, there is a minimum sales demand from Company Y that must be met:

Product	Litres	Hours	Contribution /litre	Contribution
			$	$
A: (3 hours/litre)	20	60	46	920
B: (2.5 hours/litre)	20	50	55	1,100
C: (4 hours/litre)	20	80	61	1,220
D: (4.5 hours/litre)	20	90	54	1,080
		280		4,320
Total hours available		1,345		
Hours remaining		1,065		

The remaining 1,065 hours should be used to maximise contribution, using the same priorities as before. However, maximum sales demand should be reduced by 20 litres for each product, to allow for the sales to Company Y.

The output and sales that will maximise contribution and profit, allowing for the sales to Company Y, are as follows:

Product	**Litres**	**Hours**	**Contribution/litre**	**Contribution/profit**
			$	$
B	130	325	55	7,150
A	180	540	46	8,280
C (balance)	50	200	61	3,050
		1,065		18,480
Contribution from sales to Y				4,320
Total contribution				22,800
Fixed costs				12,800
Profit				10,000

10 Shortages

Working: contribution per unit

	A	**B**	**C**	**D**
	$/unit	$/unit	$/unit	$/unit
Profit	35	55	30	55
Fixed costs:				
Production	180	240	150	270
Selling	145	225	120	215
Contribution	360	520	300	540

Resources required for the priority order for the major customer

Casing	**Units required**	**Steel**		**Direct labour**	
		per unit	Total	per unit	Total
		$	$	hours	hours
A	30	250	7,500	7.5	225.0
B	20	500	10,000	7.5	150.0
C	30	190	5,700	6.25	187.5
D	20	390	7,800	12.5	250.0
Total			31,000		812.5

(a) Steel in short supply and restricted to $250,000

Casing	**A**	**B**	**C**	**D**
	$	$	$	$
Contribution/unit	360	520	300	540
Steel costs/unit	250	500	190	390
Contribution/$1 steel cost	1.44	1.04	1.58	1.38
Ranking for manufacture	2nd	4th	1st	3rd

It is assumed that the sales forecasts for the month are correct.

Profit-maximising production schedule

	Steel used	**A**	**B**	**C**	**D**
	$	units	units	units	units
Priority order	31,000	30	20	30	20
Sales of C	51,300			270	
Sales of A	67,500	270			
Sales of D	70,200				180
	220,000				
Balance: Sales of B	30,000		60		
Total steel available	250,000				
Total production/sales		300	80	300	200

(b) Components are in short supply and restricted to 400 units

	A	**B**	**C**	**D**
Contribution/unit	$360	£520	$300	$540
Components/unit	1	1	1	1
Contribution/component	$360	$520	$300	$540
Ranking for manufacture	3rd	2nd	4th	1st

Profit-maximising production schedule

	Components used	**A**	**B**	**C**	**D**
	units	units	units	units	units
Priority order	100	30	20	30	20
Sales of D	180				180
	280				
Balance: Sales of B	120		120		
Total available	400				
Total production/sales		30	140	30	200

(c) Labour is in short supply and restricted to 2,125 hours

Casing	**A**	**B**	**C**	**D**
Contribution/unit	$360	$520	$300	$540
Labour hours/unit	7.5	7.5	6.25	12.5
Contribution per hour	$48.00	$69.33	$48.00	$43.20
Ranking for manufacture	2nd	1st	2nd	4th

Profit-maximising production schedule

	Labour hours	**A**	**B**	**C**	**D**
		units	units	units	units
Special order	812.5	30	20	30	20
Remaining hours	1,312.5		175		
Total hours	2,125.0				
Total production/sales		30	195	30	20

(d) Make or buy decision

	A	**B**	**C**	**D**
	$	$	$	$
Contribution if made	360	520	300	540
Contribution if bought in	285	475	250	490
Extra contribution if made	75	45	50	50
Labour hours	7.5	7.5	6.25	12.5
Extra contribution per hour	$10	$6	$8	$4
Ranking/priority for making	1st	2nd	3rd	4th

Profit-maximising production schedule

Casing	**Hours**	**A**	**B**	**C**	**D**
Special order	1,625	30	20	30	20
Remaining hours	2,625	175			
Total hours	4,250				
Made internally		205	20	30	20
Purchased externally		95	180	270	180
Total sales		300	200	300	200

11 Proglin

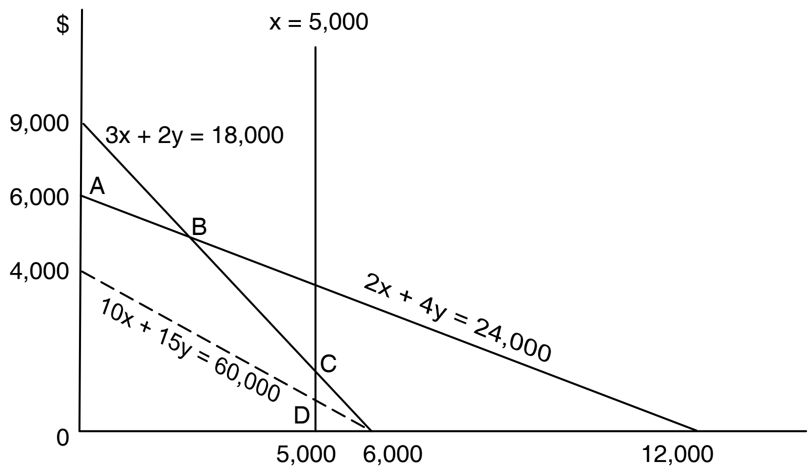
Let the number of units of Mark 1 be x
Let the number of units of Mark 2 be y.

The objective function is to maximise total contribution: 10x + 15y.

Subject to the following constraints:

Direct materials	2x + 4y	≤	24,000
Direct labour	3x + 2y	≤	18,000
Sales demand, Mark 1	x	≤	5,000
Non-negativity	x, y	≥	0

These constraints are shown in the graph below. The graph also shows an iso-contribution line 10x + 15y = 60,000.



The feasible solutions are shown by the area 0ABCD in the graph.

Using the slope of the iso-contribution line, it can be seen that contribution is maximised at point B on the graph.

At point B, we have the following simultaneous equations:

(1)	2x + 4y	=	24,000
(2)	3x + 2y	=	18,000
Multiply (2) by 2			
(3)	6x + 4y	=	36,000
Subtract (1) from (3)			
	4x	=	12,000
Therefore	x	=	3,000
Substitute in equation (1)			
	2 (3,000) + 4y	=	24,000
	4y	=	18,000
	y	=	4,500

The objective in this problem is to maximise 10x + 15y.

The total contribution where x = 3,000 and y = 4,500 is as follows:

	$
3,000 units of Mark 1 (× $10)	30,000
4,500 units of Mark 2 (× $15)	67,500
Total contribution	97,500

(b) The graph for a linear programming solution is virtually identical to the graph shown above, and the solution is still at point B. However, at point B:

(1)	$2x + 4y$	=	24,001
(2)	$3x + 2y$	=	18,000
Multiply (2) by 2			
(3)	$6x + 4y$	=	36,000
Subtract (1) from (3)			
	$4x$	=	11,999
Therefore	x	=	2,999.75
Substitute in equation (2)			
	$3\,(2{,}999.75) + 2y$	=	18,000
	$2y$	=	9,000.75
	y	=	4,500.375

The objective in this problem is to maximise 10x + 15y.

The total contribution where x = 2,999.75 and y = 4,500.375 is as follows:

	$
2,999.75 units of Mark 1 (× $10)	29,997.500
4,500.375 units of Mark 2 (× $15)	67,505.625
Total costs	97,503.125

The effect of having $1 more of direct materials would be an increase of $3.125 in total contribution.

The shadow price of direct materials is therefore $3.125 per $1 of direct materials.

12 Price

(a) If the profit margin is one-sixth of the selling price:

	$
Selling price	100.00
Profit as a % of sales price	16.67
Full cost as % of sales price	83.33

Profit as % of full cost = (16.67/83.33) × 100% = 20%.

	$
Full cost	100
Profit margin (20%)	20
Selling price	120

(b)

	$
Direct materials:	
Material M1	30
Material M2	4
Direct labour	30
Variable cost	64
Selling price	120
Mark-up	56

The required mark-up on variable cost would be 56/64 = 0.875 or 87.5%.

(c) Alternative pricing strategies are price skimming and penetration pricing.

Premium pricing would also be an acceptable solution.
Price discrimination, with different prices charged for the same product in different geographical markets, would also be acceptable.

13 Marginal

When p = 250, q = 400,000.

The quantity sold will fall by 20,000 for every $10 increase in price.

Therefore the price when q = 0 will be 250 + [(400,000/20,000) × $10] = 450

The price function can be stated as:

$P_q = 450 - (10/20{,}000)q = 450 - 0.0005q$.

Total revenue = pq = $(450 - 0.0005q)q = 450q - 0.0005q^2$

Marginal revenue = $450 - (2 \times 0.0005 \times q) = 450 - 0.001q$

Marginal cost = variable cost per unit = 210.

Profit is maximised where MR = MC:

$450 - 0.001q = 210$

$0.001q = 240$

q = 240,000 units.

At this volume of sales, p = 450 – 0.0005 (240,000) = 330.

Profit is maximised at a price of $330 per unit, and annual sales will be 240,000 units.

	$000
Sales (240,000 × $330)	79,200
Variable costs (240,000 × $210)	50,400
Contribution	28,800
Fixed costs	20,000
Profit	8,800

The annual profit will be $8,800,000.

14 MC = MR

(a) The demand falls by 1,000 units for every \$20 increase in price.

Demand will be 0 when the sales price is \$50 + \$20 × (1,000/1,000) = \$70.
The quantity demanded rises by 20/1,000 = 0.02 for every unit of demand.

The **demand curve** can therefore be expressed as:

$P = 70 - 0.02Q$

(b) **Total revenue** = $PQ = (70 - 0.02Q)Q$
$= 70Q - 0.02Q^2$

(c) Marginal revenue = $70 - 0.04Q$
Marginal cost = 8

Profit is maximised where MC = MR
$8 = 70 - 0.04Q$
$Q = 62/0.04 = 1{,}550$

$P = 70 - 0.02Q = 70 - 0.02\ (1{,}550) = 39$.

The profit is maximised at a price of \$39, when demand will be 1,550 units.
Contribution per unit will be \$31 (\$39 – \$8).
Total contribution will be \$48,050 (\$31 × 1,550).

15 Snapco

(a) (i) Full cost pricing plus, on the current basis

	\$000
Direct materials	12
Direct labour	8
Direct cost	20
Production overheads (100% of direct cost)	20
Full production cost	40
Administrative and marketing overheads (25%)	10
Full cost of sale	50
Profit (20% of full cost of sale)	10
Selling price for order (5,000 units)	60

Sales price per unit = \$12.

(ii) Price to maintain budgeted profit of \$50,000

If sales of SP8 falls are 25% below budget, the expected profit will be as follows.

		$000
Direct costs	75% × 100,000	75.0
Variable overheads	75% × 50,000	37.5
Total variable costs		112.5
Fixed production overhead		50.0
Other fixed overheads		50.0
Total costs		212.5
Sales	75% × 300,000	225.0
Profit		12.5

In order to make a profit of $50,000 for the year, the simplified units of SP8 must make $37,500 contribution to profit. The price for the order should be as follows:

	$000
Materials	12.0
Labour	8.0
Direct cost	20.0
Variable overhead (see note)	10.0
Variable cost	30.0
Contribution	37.5
Selling price	67.5

Note: Variable overheads are assumed to vary with direct materials cost. In the original budget, variable overheads are $50,000 and direct material costs are $60,000. Variable overheads are therefore 50/60 × material costs. For the simplified units, variable overheads will be $12,000 × 50/60 = $10,000.

The selling price per unit would need to be $67,500/5,000 units = $13.50.

(b) Advice

The price of SP8 is currently $15 ($300,000/20,000 units). The price for the simplified units of SP8 must be lower than this; otherwise the customer will not buy them.

A price of $13.50 is needed to achieve the budgeted profit, but the customer may be unwilling to pay this amount. A price of $12 will give a profit of 20% on full cost, using the budgeted absorption rates for overhead, but there will be some under-absorbed overheads.

Any price in excess of the minimum price of $30,000 ($6 per unit) will make profit higher than it will be if the simplified units are not sold to the customer.

However, the company must think of the longer term. Will the customer want to buy more units of the simplified product next year? If so, the company will want to charge a price at which it will make satisfactory profits.

The recommendation should therefore be to negotiate with the customer. If the agreed price is lower than $13.50, Snapco might want to warn the customer that more units of the simplified SP8 might not be available in the future, except at a higher price.

16 Bridon

(a) Budgeted variable production costs

	Cost in current year	Inflation	Cost next year Current material	New material
	$	%		
Direct material	30	20	36.0	31.25
Direct labour	10	5	10.5	10.50
Variable o'hd	10	5	10.5	10.50
	50		57.0	52.25
Cost of rejected units (5%)				2.75
				55.00

Using the cheaper substitute material will reduce the variable unit cost by $2, but fixed costs will increase by $30,000. Since annual sales at the current price will be 20,000 units, it will be more profitable to use the cheaper material.

The unit variable cost will be $55.

Annual fixed costs will be:

	$
Costs in the current year ($10 × 20,000 units)	200,000
Add inflation (10%)	20,000
Inspection costs	30,000
Total fixed costs for the year	250,000

(b) Optimal selling price

Method 1

It is assumed that the only sales prices to be considered are those in the sales manager's estimates of sales demand.

The variable cost will be $55 per unit.

Price	Contribution/ unit	Sales	Total contribution
$	$	000 units	$000
80	25	25	625
84	29	23	667
88	33	21	693
90	35	20	700
92	37	19	703
96	41	17	697
100	45	15	675

Contribution will be maximised at a price of $92, and sales will be 19,000 units.

	$
Total contribution	703,000
Fixed costs	250,000
Profit	453,000

Method 2

It is assumed that the sales manager has identified a straight-line demand curve, and any sales price on this curve may be selected.

Sales demand falls by 1,000 units for every $2 increase in the sales price.

Sales demand will be 0 when the sales price is $130 [$100 + (15 × $2)]

Demand curve:

P = 130 – 2Q, where Q is sales demand in 000s units

Total revenue TR = (130 – 2Q)Q = 130Q – $2Q^2$

Marginal revenue MR = 130 – 4Q

Marginal cost MC = variable cost per unit = 55.

Profit is maximised when MR = MC

130 – 4Q = 55

Q = 18.75

Price = 130 – 2(18.75) = $92.50.

Profit will be maximised at a price of $92.50, and the contribution per unit will be $37.50.

	$
Total contribution (18,750 × $37.50)	703,125
Fixed costs	250,000
Profit	453,125

17 Materials and relevant costs

Material X: This material is in regular use. Its relevant cost is therefore its current replacement cost, because any existing inventory will be replaced if it is used on the job.

Materials Y and Z: The relevant cost of the additional quantities that will have to be purchased is their current replacement cost.

Material Y: units already held in inventory. The relevant cost of these units is their opportunity cost, which is the cash that could be obtained by disposing of them.

Material Z: units already held in inventory. The relevant cost of these units is the higher value of their disposal value ($20 per unit) and the contribution that they would earn if they are used as a substitute material on a different job ($25 per unit)

Relevant costs		
	$	$
Material X: 800 units × $23		18,400
Material Y:		
Opportunity cost of units in inventory = disposal value (400 units × $12)	4,800	
Purchase cost of additional units (200 units × $19)	3,800	
		8,600
Material Z:		
Opportunity cost of units in inventory = (300 units × $25)	7,500	
Purchase cost of additional units (200 units × $40)	8,000	
		15,500
Total relevant cost of materials		42,500

18 Printing leaflets

(a) **Tutorial note**: The volume of sales required to achieve a target profit is an application of CVP analysis.

	$	$
Target profit		5,400
General fixed costs		12,000
Specific fixed costs:		
Leaflet Type A		7,200
Leaflet Type B		12,000
Leaflet Type C		28,500
Total contribution required		65,100
Contribution from:		
50,000 Leaflets Type A: (50 × (300 – 120))	9,000	
50,000 Leaflets Type B: (50 × (660 – 210))	22,500	
		31,500
Contribution required from Leaflets Type C		33,600

The contribution from Leaflets Type C is $(1,350 – 390) = $960 per 1,000 leaflets.

The sales quantity of Leaflets Type C required to achieve a target profit of $5,400 each month is therefore $33,600/$960 per 1,000 = 35,000 leaflets.

(b)

Relevant costs	$
Materials	
To be purchased: 10,000 × $500/1,000	5,000
Currently held in inventory	6,000
(Relevant cost = higher of [$1,500 and (20,000 × $300/1,000)]	
Variable costs of labour/overheads	2,400
(30,000 × $80/1,000)	
Total relevant costs	13,400
Contract price	25,000
Incremental profit	11,600

19 JB

The contract should be accepted if the revenue from the contract will exceed the relevant costs of the contract.

Workings

Material M1. This material is in continuous/regular use. The relevant cost of the 1,000 kilograms is their replacement cost.

Relevant cost = 400 components × 3 kilos × $5.50 per kilo = $6,600.

Material P2. The material held in inventory has a relevant cost that is the higher of its scrap value ($1.50) and the costs saved by putting it to an alternative use, which is $2 ($3.60 – $1.60).

There are more units held in stock than are needed for the contract. The excess quantity should be ignored.

Relevant cost of material in stock = 400 components × 2 kilos × $2 per kilo = $1,600.

Part 678. Relevant cost = 400 components × $50 = $20,000.

Skilled labour. The relevant cost of skilled labour is the extra cash that would have to be spent to hire additional labour.

Relevant cost = 400 components × 5 hours per component × $4 per hour = $8,000.

Semi-skilled labour. Relevant cost = 400 components × 5 hours per component × $3 per hour = $6,000.

Variable overheads. It is assumed that the overhead absorption rate for variable overheads is the rate at which cash expenditure is incurred on variable overheads.

Relevant cost = 400 components × 4 machine hours per component × $7 per machine hour = $11,200.

Relevant cost statement	$
Material M1	6,600
Material P2	1,600
Part 678	20,000
Skilled labour	8,000
Semi-skilled labour	6,000
Variable overheads	11,200
Incremental fixed costs	3,200
Total relevant costs	56,600
Contract sales value (400 × $145)	58,000
Incremental profit	1,400

Undertaking the contract will add $1,400 to total profit. On a purely financial basis, this means that the contract is worth undertaking. However, management might take the view that a higher profit margin is desirable, and the suggested price of $145 per component might be negotiable.

20 Product B22

Workings for relevant costs

Material X

The company has enough kilograms of material X in inventory for the contract. When it is used, the inventory of material X will not be replaced. The relevant cost of the material is therefore its opportunity cost, not its replacement cost. The opportunity cost is the higher of its current sale value ($7.50 per kg) or the net saving obtained if it is used as a substitute for material Z ($9.50 – $1.50 = $8 per kg). The relevant cost of material X is therefore $8 per kg.

Material Y

Material Y is in regular use, so its relevant cost is its current replacement cost.

	kg		$
Total inventory	10,000		142,750
Purchased six months ago	3,000	(× $13.75)	41,250
Purchased last month	7,000		101,500

Purchase price last month = $101,500/7,000 kg = $14.50 per kg.

Current purchase price = 4% higher = $14.50 × 1.04 = $15.08.

Skilled labour

Skilled labour is in short supply. If it is used to make product B22, workers will have to be taken off other work. The relevant cost of skilled labour is the wages for the skilled workers for the time spent on B22, plus the lost contribution (net of skilled labour cost) from not being able to make units of product B16.

Opportunity cost of skilled labour

Skilled labour cost per unit of Product B16 = $24
Number of hours per unit = 3 hours
Contribution per unit of B16 = $45
Contribution per skilled labour hour from B16 = $15
Opportunity cost of skilled labour if it is used to make B22 = (500 × 5) × $15 = $37,500

Unskilled labour

900 unskilled labour will be available at no incremental cost to the company (as it is already being paid and is not fully employed). There is no relevant cost for these hours. The additional 600 hours required will involve extra wage payments, including overtime payments. The relevant cost of these 600 hours is $6 per hour × 150% = $9 per hour, including the overtime premium.

Overheads

Variable overheads are included as relevant costs because they will be additional costs if the units of B22 are made. The only incremental fixed costs, however, are the extra cash costs of $4,000. The fixed overhead absorption rate is ignored. The additional costs of hiring special finishing machinery are also included as a relevant cost.

Development costs

Those costs already incurred are past costs (sunk costs) and are not relevant. The future development costs involve additional expenditure and are included as relevant costs.

Minimum price for making 500 units of B22

Materials:		**$**
X	(500 units × 4kg) × $8	16,000
Y	(500 units × 6kg) × $15.08	45,240
Labour:		
Skilled wages	(500 units × 5 hours) × $8	20,000
Opportunity cost	(500 units × 5 hours) × $15	37,500
Unskilled	[(500 × 3) – 900] x 6 × 1.5	5,400
Overheads:		
Variable	(500 units × 2 hours) × $8.75	8,750
Fixed	Incremental spending	4,000
Machine hire	(2 weeks × $2,650)	5,300
Development costs		1,750
Minimum price		143,940

21 Make or buy

(a)

	Component A	**Component B**
	$	$
Cost of making internally	10.0	17.0
Cost of buying	12.5	23.0
Extra variable cost of buying	2.5	6.0
Quantities required next year	30,000	20,000
	$	4
Total extra variable cost of buying	75,000	120,000
Fixed costs saved by closure	40,000	50,000
Net extra costs of buying	35,000	70,000

It appears that it would cost the company more each year to shut down internal production of either component and switch to external purchasing.

(b)

Production hours required	**hours**
Component A (30,000 × 0.25 hours)	7,500
Component B (20,000 × 0.75 hours)	15,000
Total hours required	22,500
Total hours available	19,500
Shortfall	3,000

There are insufficient hours available to manufacture everything internally. Some components must be purchased externally.

	Component A	**Component B**
	$ per unit	$ per unit
Cost of making internally	10.0	17.0
Cost of buying	12.5	23.0
Cost saved by making	2.5	6.0
Hours required to make internally	0.25 hours	0.75 hours
($3/$12 per hour: $9/$12 per hour)		
Costs saved per hour by making	$10	$8
($2.50/0.25 hours: $6/0.75 hours)		

It is better to make Component A internally than Component B.

Component	**Units**	**Hours**	**Cost/unit**	**Cost**
			$	$
A	30,000	7,500	10	300,000
B (balance)	16,000	12,000	17	272,000
Variable cost of internal manufacture		19,500		572,000
Cost of external purchase – balance of units required	4,000		23	92,000
Fixed costs				120,000
Total costs				784,000

21 Villaco

(a) Total machine hours required to meet sales demand = (2,000 × 4) + (3,000 × 1) = 11,000. Since only 7,000 hours are available, machine hours are a limiting factor.

	Product A	Product B
	$	$
Sales price	20	10
Variable cost	8	6
Contribution	12	4
Machine hours per unit	4	1
Contribution per hour	$3	$4
Priority for manufacture	2nd	1st

Decision: produce and sell the following products:

Product	Units	Machine hours	Contribution per unit	Total contribution
			$	$
B	3,000	3,000	4	12,000
A (balance)	1,000	4,000	12	12,000
		7,000		24,000

(b)

	Product A	Product B
	$	$
Extra cost of external purchase	1	0.50
Machine hours saved by external purchase	4	1
Extra cost per machine hour saved	$0.25	$0.50
Priority for manufacture	2nd	1st

Item	Number of units	Machine hours	Contribution per unit	Contribution
Make			$	$
A	1,750	7,000	12	21,000
Buy				
A (balance)	250	(12 – 1)	11	2,750
B	3,000	(4 – 0.5)	3.5	10,500
Total contribution				34,250

23 Payoff table

a)

Cost of production		Revenue from selling	
Quantity	**$**	**Quantity**	**$**
20	2	20	6
40	4	40	12
60	6	60	18

Pay-off table

	Sales demand per day		
	20	**40**	**60**
Production per day	$	$	$
20	4 (6 – 2)	4 (6 – 2)	4 (6 – 2)
40	2 (6 – 4)	8 (12 – 4)	8 (12 – 4)
60	0 (6 – 6)	6 (12 – 6)	12 (18 – 6)

b)

	Sales demand			EV of daily profit
	20	**40**	**60**	**$**
Probability	0.3	0.5	0.2	
Production per day	$	$	$	
20	4	4	4	
EV	1.2	2.0	0.8	4.0
40	2	8	8	
EV	0.6	4.0	1.6	6.2
60	0	6	12	
EV	0	3.0	2.4	5.4

On the basis of EV the decision should be to produce 40 buns per day, and the EV of daily profit will be $6.20.

24 Grab

(a) Outcomes

Decision	Outcome	Turnover	Variable cost	Advance hire	Conversion premium	Profit
Low	Low	4,000	2,800	1,000	0	200
	Medium	8,500	5,950	1,000	850	700
	High	15,000	10,500	1,000	2,150	1,350
Medium	Low	4,000	2,800	1,500	0	(300)
	Medium	8,500	5,950	1,500	0	1,050
	High	15,000	10,500	1,500	1,300	1,700
High	Low	4,000	2,800	2,300	0	(1,100)
	Medium	8,500	5,950	2,300	0	250
	High	15,000	10,500	2,300	0	2,200

(b) Pay-off matrix

	Low	Medium	High	Expected value
Probability (p)	0.30	0.45	0.25	$\sum px$
Decision	x =	x =	x =	
Low	200	700	1,350	712.5
Medium	(300)	1,050	1,700	**807.5**
High	(1,100)	250	2,200	332.5

The highest expected value is earned if the medium advance hire usage contract is signed.

(c) Risk preferences

The above decision assumes a neutral risk preference. It is possible the organisation may adopt a different decision criterion than expected value. Other decision criteria may be based on a risk-seeking approach or a risk-averse approach.

Risk-seeking managers would prefer a maximax approach. This is to maximise the highest possible outcome. In this example this would require a high advance hire contract.

Risk-averse managers would prefer a maximin approach. This is to maximise the lowest possible outcome of a course of action. This would require a low advance hire contract.

25 Zero based budgeting

Zero based budgeting is most useful when:

- There is a lot of budget slack, and wasteful spending. Zero based budgeting can be much more effective than incremental budgeting in identifying and eliminating unnecessary expenditure in a budget.
- There is a shortage of resources for 'overhead' spending, and decisions have to be made about priorities for spending.

Zero based budgeting is more effective for the planning and control of overhead spending on overhead activities than for controlling direct costs of production.

A zero based budgeting operation can be time-consuming and expensive. It should not be needed every year. A ZBB approach to the budget might be sufficient, say, every three or four years.

26 Learning

(a) (1)

	hours
Average time for 1st 2 units (200 hours × 80%)	160
Total time for 1st 2 units (160 × 2)	320
Time for first unit	200
Time for second unit	120

Selling price for the second unit:	**$**
Direct materials	2,000
Direct labour (120 hours × $15)	1,800
Fixed production overhead (120 hours × $20)	2,400
Full production cost	6,200
Profit margin (40%)	2,480
Selling price	8,680

(2)

	hours
Average time for 1st 4 units (200 hours × 80% × 80%)	128
Total time for 1st 4 units (128 × 4)	512
Time for 1st 2 units	320
Time for 3rd and 4th units	192
Average time per unit for 3rd and 4th units	96

Average price for the 3rd and 4th units:	**$**
Direct materials	2,000
Direct labour (96 hours × $15)	1,440
Fixed production overhead (96 hours × $20)	1,920
Full production cost	5,360
Profit margin (40%)	2,144
Average selling price	7,504

(3)

	hours
Average time for 1st 8 units (200 hours × 80% × 80% × 80%)	102.4
Total time for 1st 8 units (102.4 × 8)	819.2

Selling price for the first 8 units	**$**
Direct materials ($2,000 × 8)	16,000.0
Direct labour (819.2 hours × $15)	12,288.0
Fixed production overhead (819.2 hours × $20)	16,384.0
Full production cost	44,672.0
Profit margin (40%)	17,868.8
Selling price	62,540.8

This gives an average selling price of $7,817.6 per unit.

(b) (1) It may be difficult to establish an expected learning rate. Reliable statistical evidence of a constant learning rate (for example, as in the aircraft manufacturing industry) is required.

(2) Learning curve theory is of little value for the development of low-cost items where direct labour input is small. The benefits from the learning curve would be small and fairly insignificant.

(3) Learning curve theory assumes that when the first unit has been made, every other unit will be similar. It does not allow for changes in design or other factors that could disrupt the learning effect and change the learning rate.

27 Greenears

The cost of producing batches 6 – 12 is the difference between:

- the cost of producing batches 1 – 5, and
- the cost of producing batches 1 – 12.

(1) Learning factor

$$\frac{\text{Logarithm } 0.85}{\text{Logarithm } 2} = \frac{-0.07058}{0.30103} = -0.23446$$

(2) Average labour cost of producing the first 5 batches

$$y = \$2{,}000 \times \frac{1}{5^{0.23446}}$$

= \$2,000 (0.68568)

= \$1,371 per batch

(3) Average labour cost of producing the first 12 batches

$$y - \$2{,}000 \times \frac{1}{12^{0.23446}}$$

= \$2,000 (0.55844)

= \$1,117 per batch

(4) Labour cost of producing batches 6 – 12

	$
Total cost for the first 12 batches (12 × \$1,117)	13,404
Total cost for the first 5 batches (5 × \$1,371)	6,855
Labour cost for batches 6 – 12	6,549

28 Regression

(a)

$$b = \frac{5(254) - (15)(79)}{5(55) - (15)(15)}$$

$$= \frac{1{,}270 - 1{,}185}{275 - 225}$$

b = 85/50 = 1.7

$$a = \frac{79}{5} - \frac{1.7(15)}{5}$$

a = 10.7

Forecast: Sales in \$millions = 10.7 + 1.7x

Forecast for Year 6 = 10.7 + 1.7(6) = 20.9 (\$20.9 million)

Forecast for Year 7 = 10.7 + 1.7(7) = 22.6 (\$22.6 million).

(b)

$$r = \frac{85}{\sqrt{(50)[5(1,279) - (79)(79)}}$$

r = 85/87.75 = + 0.97

This is very close to + 1, suggesting that the forecast will be very reliable.

29 Flexed budget

Workings

The high low method will be used to estimate fixed and variable costs.

	Production labour	Production overhead
	$	$
Total cost of 13,000 units	81,500	109,000
Total cost of 10,000 units	74,000	88,000
Variable cost of 3,000 units	7,500	21,000

Variable production labour cost per unit = $7,500/3,000 units = $2.50.

Variable production overhead cost per unit = $21,000/3,000 units = $7.00.

	Production labour	Production overhead
	$	$
Total cost of 10,000 units	74,000	88,000
Variable cost of 10,000 units (× $2.50/$7)	25,000	70,000
Fixed costs	49,000	18,000

Selling and distribution overhead	$
Total cost of 14,000 units	36,200
Total cost of 9,000 units	29,700
Variable cost of 5,000 units	6,500

Variable selling and distribution overhead cost per unit = $6,500/5,000 units = $1.30.

Selling and distribution overhead	$
Total cost of 9,000 units	29,700
Variable cost of 9,000 units (× $1.30)	11,700
Fixed costs	18,000

Summary	Fixed cost	Variable cost per unit
	$	$
Direct materials ($130,000/10,000 units)	-	13.00
Direct labour (excluding overtime)	49,000	2.50
Production overhead	18,000	7.00
Administration overhead (all fixed)	26,000	-
Selling and distribution overhead	18,000	1.30

Budgeted cost allowance – quarter 3	
Production units: 15,000	
Sales units: 14,500	
	$
Materials (15,000 × $13)	195,000
Labour ($49,000 + (15,000 × $2.50))	86,500
Overtime (1,000 × $2.50 × 50%)	1,250
Production 0verhead ($18,000 + (15,000 × $7))	123,000
Administration overhead	26,000
Selling and distribution ($18,000 + (14,500 × $1.30))	36,850
	468,600

30 Cost estimation

(a) **High low method**

		$
Total cost of	22,000 units	74,000
Total cost of	12,000 units	52,000
Therefore variable cost of	10,000 units	22,000

Variable cost per unit = $22,000/10,000 units = $2.20.

			$
Total cost of	22,000 units		74,000
Variable cost of	22,000 units	(× $2.20)	48,400
Therefore fixed costs	10,000 units		25,600

Fixed costs = $25,600 per month.

In a month when output is 15,000 units, the estimated total costs are:

		$
Fixed costs		25,600
Variable costs	(15,000 × $2.20)	33,000
Total costs		58,600

(b) **Linear regression analysis**

Workings

Output	**Total cost**			
x	**y**	**x^2**	**xy**	**y^2**
17	63	289	1,071	3,969
15	61	225	915	3,721
12	52	144	624	2,704
22	74	484	1,628	5,476
18	68	324	1,224	4,624
84	318	1,466	5,462	20,494

$$b = \frac{5(5{,}464) - (84)(318)}{5(1{,}466) - (84)^2}$$

$$= \frac{27{,}310 - 26{,}712}{7{,}330 - 7{,}056}$$

$$= \frac{598}{274} = 2.18$$

$$a = \frac{318}{5} - \frac{2.18(84)}{5}$$

$$= 63.6 - 36.6 = 27.0$$

Variable costs = $2.18 per unit and fixed costs per month are $27,000.

		$
Fixed costs		27,000
Variable costs	(15,000 × $2.18)	32,700
Total costs		59,700

(c) **Correlation coefficient**

$$r = \frac{598}{\sqrt{(274)\left[5(20{,}494) - (318)^2\right]}}$$

$$= \frac{598}{\sqrt{(274)(102{,}470 - 101{,}124)}}$$

$$= \frac{598}{\sqrt{(274)(1{,}346)}}$$

$$= \frac{598}{607.3} = 0.98$$

A correlation coefficient close to + 1 indicates very strong positive correlation. The estimate of total costs using linear regression analysis should be very reliable.

31 Time series

Sales are recorded for each quarter. We can therefore assume that seasonal variations are quarterly, which means that there are four 'seasons' in each cycle.

A trend line has already been calculated. Seasonal variations can be estimated by taking the average of historical variations. The total of all variations in one cycle must add up to 0.

Periods	Quarter 1 variation	Quarter 2 variation	Quarter 3 variation	Quarter 4 variation	Total
	$000	$000	$000	$000	$000
3 – 6	– 12	– 20	+ 26	+ 6	
7 – 10	– 14	– 17	+ 22	0	
11 - 14	– 7	– 17	+ 30	+ 3	
Average	– 11	– 18	+ 26	+ 3	0

The average seasonal variations add up to 0 exactly; therefore no further adjustments are needed. These average variations will be used for the purpose of sales forecasting.

Period	Trend (1,080 + 40P)	Seasonal variation	Forecast sales
	$000	$000	$000
17	1,760	–11	1,749
18	1,800	– 18	1,782
19	1,840	+ 26	1,866
20	1,880	+ 3	1,883

The sales forecast should be reliable only if the trend in sales that has happened in the past continues into the future, and that the estimates of seasonal variations are reasonably accurate. Some error in forecasting is inevitable even if these assumptions are valid.

There is also some risk of error in the estimate of the trend line, but this can be evaluated using a correlation coefficient, assuming that the trend line was calculated using linear regression analysis.

There is also some risk of a small error in the estimate of seasonal variations, where simple arithmetical averages of variations in the past three years have been used.

32 Reconcile

Workings

Direct materials total cost variance		
	$	
14,800 units should cost (× $8)	118,400	
They did cost	125,000	
Direct materials total cost variance	6,600	(A)

Direct labour total cost variance		
	$	
14,800 units should cost (× $6)	88,800	
They did cost	92,000	
Direct labour total cost variance	3,200	(A)

Fixed production overheads total cost variance		
	$	
14,800 units: standard fixed overhead cost (× $12)	177,600	
Actual fixed overhead cost	170,000	
Fixed production overheads total cost variance	7,600	(F)

Note: The fixed overhead total cost variance can be divided into:

(a) an expenditure variance

(b) a volume variance

Fixed production overheads expenditure variance		
	$	
Budgeted fixed overhead expenditure (14,000 × $12)	168,000	
Actual fixed overhead expenditure	170,000	
Fixed production overheads expenditure variance	2,000	(A)

Fixed production overheads volume variance		
	units	
Budgeted units of production	14,000	
Actual units produced	14,800	
Fixed production overheads volume variance in units	800	(F)
Standard fixed overheads per unit	$12	
Fixed production overheads volume variance in $	$9,600	(F)

Solution

Reconciliation statement		
	$	
Budgeted costs for the month (14,000 units × $26)	364,000	
Extra standard costs of additional production (800 units × $26)	20,800	
Standard costs of actual production (14,800 units × $26)	384,800	
Cost variances		
Direct materials total cost variance	6,600	(A)
Direct labour total cost variance	3,200	(A)
Fixed overheads expenditure variance	2,000	(A)
Fixed overheads volume variance	9,600	(F)
Actual total costs in the month	387,000	

33 Simple variances

(a)

Direct labour rate variance		
	$	
13,450 hours should cost (× $6)	80,700	
They did cost	79,893	
Labour rate variance	807	(F)

Direct labour efficiency variance

	hours	
3,350 units should take (× 4 hours)	13,400	
They did take	13,450	
Efficiency variance in hours	50	(A)
Standard rate per hour	$6	
Direct labour efficiency variance in $	$300	(A)

(b)

Sales price variance	$	
850 units should sell for (× £9)	7,650	
They did sell for	7,480	
Sales price variance	170	(A)

Sales volume variance, absorption costing

	units	
Actual sales volume (units)	850	
Budgeted sales volume (units)	800	
Sales volume variance in units	50(F)	
Standard profit per unit	$2	
Sales volume variance (profit variance) in $	$100	(F)

Sales volume contribution variance, marginal costing

Sales volume variance in units	50 (F)	
Standard contribution per unit ($9 - $4)	$5	
Sales volume variance (contribution variance)	$250	(F)

(c)

(i)

Fixed production overhead total cost variance

	$	
Standard fixed overhead cost of 14,600 units (× $20)	292,000	
Actual fixed overhead expenditure	325,000	
Fixed overhead total cost variance (under-absorption)	3,000	(A)

(ii)

Fixed production overhead expenditure variance		
	$	
Budgeted fixed overhead expenditure (15,000 × $20)	300,000	
Actual fixed overhead expenditure	325,000	
Fixed overhead expenditure variance	25,000	(A)

Fixed production overhead volume variance		
	units	
Budgeted production volume	15,000	
Actual production volume	14,600	
Volume variance in units	400	(A)
Standard fixed overhead rate per unit	$20	
Fixed production overhead volume variance in $	$8,000	(A)

(iii)

Fixed production overhead efficiency variance		
	hours	
14,600 units should take × 4 hours)	58,400	
They did take	58,000	
Efficiency variance in hours	400	(F)
Standard fixed overhead rate per hour	$5	
Fixed production overhead efficiency variance in $	$2,000	(F)

Fixed production overhead capacity variance	**hours**	
Budgeted hours of work (15,000 × 4 hours)	60,000	
Actual hours of work	58,000	
Capacity variance in hours	2,000	(A)
Standard fixed overhead rate per hour	$5	
Fixed production overhead capacity variance in $	$10,000	(A)

34 Manufacturing cost variance

Material price variance

	$	
120,000 kilos of materials should cost (× $6)	720,000	
They did cost	825,000	
Material price variance	105,000	(A)

Material usage variance

	kilos	
20,000 units should use (× 5 kilos)	100,000	
They did use	120,000	
Material usage variance in kilos	20,000	(A)
Standard price per kilo of material	$6	
Material usage variance in $	$120,000	(A)

Direct labour rate variance

	$	
500,000 hours should cost (× $4)	200,000	
They did cost (× $5)	250,000	
Labour rate variance	50,000	(A)

Direct labour idle time variance = 10,000 hours (A) × $4 per hour = $40,000 (A)

Direct labour efficiency variance

	hours	
20,000 units should take (× 20 hours)	400,000	
They did take (500,000 – 10,000)	490,000	
Efficiency variance in hours	90,000	(A)
Standard rate per hour	$4	
Direct labour efficiency variance in $	$360,000	(A)

Variable overhead total cost variance

	$	
20,000 units should cost (× $4)	80,000	
They did cost	70,000	
Variable overhead total cost variance	10,000	(F)

Fixed production overhead expenditure variance

	$	
Budgeted fixed overhead expenditure (25,000 units × $100)	2,500,000	
Actual fixed overhead expenditure	2,100,000	
Fixed overhead expenditure variance	400,000	(F)

Fixed production overhead volume variance

	units	
Budgeted production volume	25,000	
Actual production volume	20,000	
Volume variance in units	5,000	(A)
Standard fixed overhead rate per unit	$100	
Fixed production overhead volume variance in $	$500,000	(A)

Summary

Variance	**Favourable**	**Adverse**		
	$	$		
Material price		105,000		
Material usage		120,000		
Direct labour rate		50,000		
Direct labour idle time		40,000		
Direct labour efficiency		360,000		
Variable overhead cost	10,000			
Fixed overhead expenditure	400,000			
Fixed overhead volume		500,000		
	410,000	1,175,000		
Manufacturing cost total variance			$765,000	(A)

35 Variances and operating statements

(a) **Standard absorption costing**

Budgeted fixed overheads = $2,400

Budgeted labour hours = 2,400 hours

Budgeted fixed overhead rate per hour = $1.

Materials price variance

	$	
25,000 kilos of materials should cost (× $1.50)	37,500	
They did cost (× $1.48)	37,000	
Material price variance	500	(A)

Materials usage variance

	kilos	
11,500 units of Product Q should use (× 2 kilos)	23,000	
They did use	25,000	
Material usage variance in kilos	2,000	(A)
Standard price per kilo of material	$1.50	
Material usage variance in $	$3,000	(A)

The material price variance and the material usage variance add up to the material total cost variance.

Direct labour rate variance

	$	
2,320 hours should cost (× $3.20)	7,424	
They did cost	7,540	
Labour rate variance	116	(A)

Direct labour efficiency variance

	hours	
11,500 units of Product Q should take (× 0.20 hours)	2,300	
They did take	2,320	
Efficiency variance in hours	20	(A)
Standard rate per hour	$3.20	
Direct labour efficiency variance in $	$64	(A)

Variable overhead expenditure variance

	$	
2,320 hours should cost (× $0.80)	1,856	
They did cost	1,750	
Labour rate variance	106	(F)

Variable overhead efficiency variance = 20 hours (A) × $0.80 per hour = $16 (A).

Fixed production overhead expenditure variance

	$	
Budgeted fixed overhead expenditure	2,400	
Actual fixed overhead expenditure	2,462	
Fixed overhead expenditure variance	62	(A)

Fixed production overhead volume variance

	units	
Budgeted production volume	12,000	
Actual production volume	11,500	
Volume variance in units	500	(A)
Standard fixed overhead rate per unit	$0.20	
Fixed production overhead volume variance in $	$100	(A)

Sales price variance	$	
10,000 units should sell for (× $6)	60,000	
They did sell for	62,600	
Sales price variance	2,600	(F)

Sales volume profit variance

	units	
Actual sales volume (units)	10,000	
Budgeted sales volume (units)	12,000	
Sales volume variance in units	2,000	(A)
Standard profit per unit	$2	
Sales volume variance (profit variance)	$4,000	(A)

Operating statement (standard absorption costing)

	$	
Budgeted profit (12,000 units × $2)	24,000	
Sales price variance	2,600	(F)
Sales volume variance	4,000	(A)
	22,600	

Cost variances	(F)	(A)		
	$	$		
Direct materials price	500			
Direct materials usage		3,000		
Direct labour rate		116		
Direct labour efficiency		64		
Variable production overhead expenditure	106			
Variable production o'head efficiency		16		
Fixed production overhead expenditure		62		
Fixed production overhead volume		100		
Total cost variances	606	3,358	2,752	(A)
Actual profit			19,848	

(b) **Standard marginal costing**

Sales volume contribution variance

Sales volume variance in units	2,000	(A)
Standard contribution per unit	$2.20	
Sales volume variance (contribution variance)	$4,400	(A)

Operating statement: standard marginal costing

	$	
Budgeted profit	24,000	
Add budgeted fixed costs	2,400	
Budgeted contribution	26,400	
Sales price variance	2,600	(F)
Sales volume variance	4,400	(A)
	24,600	

Variable cost variances	(F)	(A)
	$	$
Direct materials price	500	
Direct materials usage		3,000
Direct labour rate		116
Direct labour efficiency		64
Variable production o'head expenditure	106	

Variable production o'head efficiency		16	
Total variable cost variances	606	3,196	2,590 (A)
Actual contribution			22,010
Budgeted fixed overhead expenditure		2,400	
Fixed overhead expenditure variance		62 (A)	
Actual fixed production overheads			2,462
Actual profit			19,548

Note: The difference in profit is accounted for by the difference in the increase in closing inventory (1,500 units × $0.20 per unit fixed overhead in inventory, absorption costing = $300).

36 Standard costing

(a)

	$	$
Budgeted net profit (10,000 units × $16)		160,000
Sales variances:		
Sales price variance	36,000 (F)	
Sales volume variance	16,000 (A)	
		20,000 (F)
		180,000
Cost variances:		
Materials variances:		
Material A price variance	3,800 (A)	
Material B price variance	4,040 (F)	
Total material price variance		240 (F)
Material A usage variance	2,000 (A)	
Material B usage variance	6,600 (A)	
Total material usage variance		8,600 (A)
Labour variances:		
Rate variance	11,400 (A)	
Efficiency variance	9,000 (A)	
		20,400 (A)
Variable overhead variances:		
Expenditure variance	10,000 (F)	
Efficiency variance	6,000 (A)	
		4,000 (F)
Fixed overhead variances:		
Expenditure variance	8,000 (F)	

Efficiency variance	12,000	(A)		
Capacity variance	12,000	(A)		
			16,000	(A)
Actual profit			$139,240	

Workings

Sales price variance	**$**	
9,000 units should sell for (× $80)	720,000	
They did sell for	756,000	
Sales price variance	36,000	(F)

Sales volume variance	**units**	
Budgeted sales units	10,000	
Actual sales units	9,000	
Sales volume variance in units	1,000	(A)
Standard profit per unit	$16	
Sales volume variance in $	$16,000	(A)

Materials price variances	**$**	
19,000 kilos of Material A should cost (× $2)	38,000	
They did cost	41,800	
Material A price variance	3,800	(A)
10,100 kilos of Material B should cost (× $6)	60,600	
They did cost	56,560	
Material B price variance	4,040	(F)

Materials usage variances	**Material A**		**Material B**	
	kilos		kilos	
9,000 units of product should use (× 2 kg/1kg)	18,000		9,000	
They did use	19,000		10,100	
Material usage variance in kilos	1,000	(A)	1,100	(A)
Standard cost per kilo	$2		$6	
Material usage variance in $	$2,000	(A)	$6,600	(A)

Labour rate variance	$	
28,500 hours of labour should cost (× $6)	171,000	
They did cost	182,400	
Labour rate variance	11,400	(A)

Labour efficiency variances	hours	
9,000 units of product should take (× 3 hours)	27,000	
They did use	28,500	
Efficiency variance in hours	1,500	(A)
Standard cost per hour	$6	
Labour efficiency variance in $	$9,000	(A)

Variable overhead expenditure variance	$	
28,500 hours should cost (× $4)	114,000	
They did cost	104,000	
Labour rate variance	10,000	(F)

Variable overhead efficiency variance:

Efficiency variance in hours (see above): 1,500 hours (A)

Efficiency variance = 1,500 hours (A) × $4 per hour = $6,000 (A).

Fixed overhead expenditure variance	$	
Budgeted fixed overheads (10,000 units × $24)	240,000	
Actual fixed overheads	232,000	
Fixed overhead expenditure variance	8,000	(F)

Fixed overhead efficiency variance:

Efficiency variance in hours (see above): 1,500 hours (A)
Efficiency variance = 1,500 hours (A) × $8 per hour = $12,000 (A).

Fixed overhead capacity variance	hours	
Budgeted hours of work (10,000 units × 3 hours)	30,000	
Actual hours of work	28,500	
Capacity variance in hours	1,500	(A)
Standard fixed overhead cost per hour	$8	
Fixed overhead capacity variance in $	$12,000	(A)

(b) **Standard marginal costing**

In a standard marginal costing system, the sales volume variance would be evaluated using standard contribution per unit. The sales volume variance would be 1,000 units (A) × standard contribution per unit $40 = $40,000 (A).

This is $24,000 higher than the sales volume variance in an absorption costing system.

There would be no fixed overhead volume variances in marginal costing. There would therefore be no fixed overhead efficiency or capacity variance, totalling $12,000 + $12,000 = $24,000 (A).

Since sales and production volumes are the same, the net profit in marginal costing is the same as the net profit in absorption costing.

37 Sales variances

Sales price variances	**$**	**$**	
520 units of Q should sell for (× $30)	15,600		
They did sell for	14,560		
Product Q sales price variance		1,040	(A)
290 units of R should sell for (× $45)	13,050		
They did sell for	14,210		
Product R sales price variance		1,160	(F)
90 units of S should sell for (× $65)	5,850		
They did sell for	5,670		
Product S sales price variance		180	(A)
Total sales price variances		60	(A)

	Product Q		**Product R**		**Product S**		**Total**	
	units		units		units			
Budgeted sales	600		300		100			
Actual sales	520		290		90			
Sales volume variance (units)	80	(A)	10	(A)	10	(A)		
Standard margin per unit	$10		$15		$25			
Sales volume variance ($)	$800	(A)	$150	(A)	$250	(A)	$1,200	(A)

The sales volume variance can be analysed between a sales mix and a sales quantity variance:

Mix variance

	Actual mix	**Actual total quantity in standard mix**	**Mix variance**	**Standard margin per unit**	**Mix variance**
	units	units	units	$	$
Q	520	540	20 (A)	10	200 (A)
R	290	270	20 (F)	15	300 (F)
S	90	90	-	25	0
	900	900			100 (F)

Average standard margin per unit = $(6,000 + 4,500 + 2,500)/1,000 units
= $13 per unit

	Total
	units
Budgeted sales	1,000
Actual sales	900
Sales volume variance (units)	100 (A)
Average standard margin per unit	$13
Sales volume variance ($)	$1,300 (A)

38 Mix and yield variances

	$
5 litres of material P should cost (× $0.70)	3.50
5 litres of material Q should cost (× $0.92)	4.60
10 litres of input material should cost	8.10
= 9 litres of finished product (lubricant)	

Standard material cost per litre of lubricant = $8.10/9 litres = $0.90 per litre.

Standard average cost per litre of input = $8.10/10 litres = $0.81 per litre.

Total material cost variance	**$**
92,070 litres of lubricant should cost (× $0.90)	82,863
They did cost ($36,000 + $53,350)	89,350
Total material cost variance	6,487 (A)

Materials price variances	**$**	**$**	
45,000 litres of Material P should cost (× $0.70)	31,500		
They did cost	36,000		
Material P price variance		4,500	(A)
55,000 litres of Material Q should cost (× $0.92)	50,600		
They did cost	53,350		
Material Q price variance		2,750	(A)
Total material price variances		7,250	(A)

Materials usage variances	**Material P**		**Material Q**	
	litres		litres	
92,070 litres of lubricant should use (× 10/9 × 50%)	51,150		51,150	
They did use	45,000		55,000	
Material usage variance in kilos	6,150	(F)	3,850	(A)
Standard cost per kilo	$0.70		$0.92	
Material usage variance in $	$4,305	(F)	$3,542	(A)
Total material usage variance = $4,305 (F) + $3,542 (A) =			$763	(F)

Mix variance

	Actual mix	**Actual total quantity in standard mix**	**Mix variance**		**Standard cost per litre**	**Mix variance**	
	litres	litres	litres		$	$	
P	45,000	50,000	5,000	(F)	0.70	3,500	(F)
Q	55,000	50,000	5,000	(A)	0.92	4,600	(A)
	100,000	100,000				1,100	(A)

Materials yield variance	**litres**	
92,070 litres of lubricant should use (× 10/9)	102,300	
They did use (45,000 + 55,000)	100,000	
Yield variance in litres	2,300	(F)
Standard average cost per litre of input	$0.81	
Materials yield variance in $	$1,863	(F)

Summary	$	$
Materials price variances		7,250 (A)
Materials mix variance	1,100 (A)	
Materials yield variance	1,863 (F)	
Materials usage variance		763 (F)
Total materials cost variance		6,487 (A)

39 More mix and yield

(a)

Direct materials price variance	$	$
6,700 kilos of material X should cost (× $8)	53,600	
They did cost	51,400	
Material X price variance		2,200 (F)
2,900 kilos of material Y should cost (× $12)	34,800	
They did cost	39,500	
Material Y price variance		4,700 (A)
Total direct materials price variance		2,500 (A)

Materials mix variance

Material	Actual usage		Actual usage in standard mix	Mix variance		Standard price per kilo	Mix variance	
	kilos		kilos	kilos		$	$	
X	6,700	(5)	6,000	700	(A)	8	5,600	(A)
Y	2,900	(3)	3,600	700	(F)	12	8,400	(F)
	9,600		9,600				2,800	(F)

Standard weighted average cost per kilo of materials = $76/8 kilos = $9.50 per kilo.

Direct materials yield variance	kilos	
1,250 units should use (× (3 + 5) kilos)	10,000	
They did use	9,600	
Materials yield variance in kilos	400	(F)
Standard weighted average cost per kilo	$9.50	
Direct materials yield variance in $	$3,800	(F)

(b)

Summary	**$**	
Standard materials cost of 1,250 units (× 76)	95,000	
Materials price variance	2,500	(A)
Materials mix variance	2,800	(F)
Materials yield variance	3,800	(F)
Actual materials cost	90,900	

40 Planning and operational variances

(a) **Operational variances** (using the retrospective or ex post standard cost).

Direct labour rate variance	**$**	
8,200 hours should cost (× $15)	123,000	
They did cost	120,800	
Direct labour rate variance	2,200	(F)

Direct labour efficiency variance	**hours**	
2,000 units should take (× 4 hours)	8,000	
They did take	8,200	
Efficiency variance in hours	200	(A)
Standard cost per labour hour	$15	
Direct labour efficiency variance in $	$3,000	(A)

Planning variance	**$**	
Standard cost of 2,000 units:		
Original (ex ante) standard (× 3 hours × $15)	90,000	
Revised (ex post) standard (× 4 hours × $15)	120,000	
Planning variance	30,000	(A)

The planning variance is adverse because the original standard cost was too optimistic.

Summary	**$**	
Original standard cost of 2,000 units	90,000	
Planning variance	30,000	(A)
Revised standard cost of 2,000 units	120,000	
Operational variances		
Direct labour rate	2,200	(F)
Direct labour efficiency	3,000	(A)
Actual direct labour cost	120,800	

(b)

Direct labour rate variance	**$**	
8,200 hours should cost (× $12)	98,400	
They did cost	101,600	
Direct labour rate variance	3,200	(A)

Direct labour efficiency variance	**hours**	
2,000 units should take (× 4 hours)	8,000	
They did take	8,200	
Efficiency variance in hours	200	(A)
Standard cost per labour hour	$12	
Direct labour efficiency variance in $	$2,400	(A)

Planning variance	**$**	
Standard cost of 2,000 units:		
Original (ex ante) standard (2,000 × 3 hours × $15)	90,000	
Revised (ex post) standard (2,000 × 4 hours × $12)	96,000	
Total planning variance	6,000	(A)

The planning variance can be analysed into:

- a planning variance caused by a change in the time for each unit. This is (4 hours – 3 hours) = 1 hour per unit (A)
- a planning variance caused by a change in the rate per hour. This is ($15 – $12) = $3 per hour (F).

(Note: A planning variance is adverse if the ex ante standard is too optimistic and favourable if it over-estimates costs).

However, there are two ways of analysing the total planning variance:

- Efficiency planning variance = 2,000 units × 1 hour per unit (A) × $15 per hour = $30,000 (A)
- Labour rate planning variance = 2,000 units × 4 hours per unit × $3 per hour (F) = $24,000 (F)
- Alternatively:
- Efficiency planning variance = 2,000 units × 1 hour per unit (A) × $12 per hour = $24,000 (A)
- Labour rate planning variance = 2,000 units × 3 hours per unit × $3 per hour (F) = $18,000(F).

Summary	$	
Original standard cost of 2,000 units	90,000	
Efficiency planning variance	30,000	(A)
Rate per hour planning variance	24,000	(F)
Revised standard cost of 2,000 units	96,000	
Operational variances		
Direct labour rate	3,200	(A)
Direct labour efficiency	2,400	(A)
Actual direct labour cost	101,600	

41 Size and share

The budgeted sales volume for the company was 120,000 units and the budgeted market size was 600,000 units. The budgeted market share was therefore 20%.

Sales price variance	$	
114,000 units should sell for (× $10)	1,140,000	
They did sell for (× $10.50)	1,197,000	
Sales price variance	57,000	(F)

The standard contribution per unit is $6 (= $10 – $4).

The sales volume variance could be calculated, but this is unnecessary since

Market size variance	units	
Budgeted market size	600,000	
Actual market size	550,000	
Difference	50,000	
Budgeted market share	20%	
Market sze varance in units	10,000	(A)
Standard contribution per unit	$6	
Market size variance in $ contribution	$60,000	(A)

Market share variance	units	
Expected share of market for actual market size	110,000	
(20%× 550,000 units)		
Actual sales volume	114,000	
Market share variance in units	4,000	(F)

Standard contribution per unit	$6
Market share variance in $ contribution	$24,000 (F)

Summary	$	
Budgeted contribution (120,000 × $6)	720,000	
Sales price variance	57,000	(F)
Market size variance	60,000	(A)
Market share variance	24,000	(F)
Actual contribution (114,000 × $6.50)	741,000	

Sales prices were higher than expected but the total market size was smaller than budgeted. There may be some connection between higher sales prices and the smaller-than-expected market size.

The company has achieved a market share of 20.7% (114,000/550,000) which is above the budgeted market share. This has resulted in higher sales volume to offset partially the decline in the size of the market.

In summary, actual contribution was more than budget due to higher sales prices and a good market share, but the company may be concerned about the effect of higher sales prices on the market size in the future and the possibility that the market may continue to decline in the future..

42 Learning curve variance

Note: This answer uses rounding for some of the calculations, and your answer may differ from the one provided here due to rounding differences.

The expected learning rate is 85%.
The cumulative average time per unit produced is therefore ax^b
where b = log 0.85/log 2.

Log 0.85/log 2 = - 0.0758/0.3010 = - 0.2518

Therefore the cumulative average time per unit = $a/x^{0.2518}$

In this example, x = 7, and $x^{0.2518}$ = 1.63228.

		Expected cost per unit	Expected cost in total (7 units)
		$	$
Direct labour	$30,000/ 1.63228	18,379	128,653
Labour-related other costs	$2,000/1.63228	1,225	8,575

	Expected cost	Actual cost	Variance	
	$	$	$	
Direct materials (14,000 × 7)	98,000	95,000	3,000	(F)
Direct labour	128,653	160,000	31,347	(A)
Other costs: 8,575 + (3,000 × 7)	29,575	29,400	175	(F)

The variances show a large adverse labour cost variance. Since the labour rate variance is $0, the entire variance must be an adverse efficiency variance.

However the variance is calculated on the assumption that the learning rate should be 85%. Unless there are obvious reasons for inefficiency, it would seem that the learning rate is not as good as 85% but it could be difficult to establish the cause if the variance is investigated.

43 Balanced

(a) The four perspectives for performance targets and measuring performance in a balanced scorecard approach are:

(1) a customer perspective: identifying what customers value most

(2) an internal systems perspective: identifying the processes that must be performed with excellence to satisfy customers

(3) an innovation and learning perspective: what must the organisation do to innovate or add to its knowledge and experience

(4) a financial perspective.

(b) **A professional football club**

Here are some suggestions

Customer perspective

Customers value:

- results, winning
- an enjoyable time at football matches: being entertained (for example, with food and drink).

Targets for performance might be:

- the size of attendances at matches
- results (points, position in the league table, promotion)
- revenue from catering: number of meals sold before matches.

Internal processes perspective

Processes that must be excellent to support customer expectations might include ticket selling, getting customers into the ground quickly on match days, catering efficiency, effective security and policing, and so on.

Targets for performance might be:

- number of season ticket sales
- targets for number of spectators per minute going through each turnstile
- speed of producing meals in the catering area
- number of incidents and police arrests on match days.

Innovation and learning perspective

Value can be created by developing well-trained footballers through coaching and training, and possibly selling them in the transfer market to make profits.

Targets for performance might be:

- average fitness levels for players
- average number of hours of training each week per player
- revenue from transfers

Financial perspective

Presumably, the football club will be expected to make profits for its owners. Targets for performance might be profits each year, and return on investment.

Subsidiary financial targets might be average wages per player, and revenue from sponsorship deals.

44 Pyramid

(a) The performance pyramid describes a view that all measures of performance for an organisation should be linked and consistent with each other. There is a hierarchy of suitable measures of performance, with performance measures at lower levels in the hierarchy (or pyramid) supporting performance measures at a higher level.

(1) At the bottom of the pyramid, there are operational performance measures, relating to external effectiveness and internal efficiency.

(2) Operational performance measures support higher-level measures that should relate to quality, delivery, production or service cycle time and waste.

(3) These measures of performance support measures of performance at an even higher level in the pyramid, relating to customer satisfaction, flexibility and productivity.

(4) These measures of performance support measures relating to market satisfaction and financial performance.

(5) Together, measures of market satisfaction and financial performance support the achievement of the organisation's objectives.

The performance pyramid recognises that external and market measures of performance are as important as financial performance and internal efficiency in achieving the long-term objectives of the organisation.

(b) Dimensions of performance in service industries may be measured primarily by:

(1) financial performance and

(2) competitiveness.

These should be supported by performance in four other dimensions:

(1) service quality

(2) flexibility

(3) resource utilisation and

(4) innovation.

45 Three services

(a) Workings

Revenue:

Service A contract customers: 350,000 × 60% × \$9 × 1.03 = \$1,946,700

Service A non-contract customers: 350,000 × 40% × \$9 × 1.30 × 1.03 = \$1,687,140

Service B contract customers: 250,000 × 60% × \$15 × 1.03 = \$2,317,500

Service B non-contract customers: 250,000 × 40% × \$15 × 1.50 × 1.03 = \$2,317,500

Service C contract customers: 20,000 × 80% × \$300 × 1.03 = \$4,944,000

Service C non-contract customers: 20,000 × 20% × \$300 × 1.20 × 1.03 = \$1,483,200

Salaries: \$45,000 × 85 employees × 1.05 = \$4,016,250

Sundry operational costs: \$4,000,000 ×1.05 = \$4,200,000

Fuel

Services A and B: 400 km × 50 vehicles × 300 days × \$0.40 = \$2,400,000

Service C: 600 km × 18 vehicles × 300 days × \$0.80 = \$2,592,000

Budgeted income statement for the year to 31st December Year 2

	Service A	**Service B**	**Service C**	**Total**
Revenue:	**\$**	**\$**	**\$**	**\$**
Contract customers	1,946,700	2,317,500	4,944,000	9,208,200
Non-contract customers	1,687,140	2,317,500	1,483,200	5,487,840
Total revenue	3,633,840	4,635,000	6,427,200	14,696,040
Costs:				
Salaries			4,016,250	
Fuel:				

Services A and B	2,400,000		
Service C	2,592,000		
		4,992,000	
Sundry operational costs		4,200,000	
Total costs			13,208,250
Net profit			1,487,790

(b) Vehicle utilisation

There is no information about weight carried, only about distance travelled.

All vehicles were used for 300 days in the year. Presumably, vehicles might be used for 365 days per year, indicating an overall utilisation ratio for all vehicles of 82.2%.

Other utilisation measure: a revenue measure might be used as an indication of the utilisation of vehicles.

	Services A and B	Service C
Revenue per vehicle	($8,268,840/50)	($6,427,200/18)
	$165,377	$357,067

Kilometres travelled each year might also be a measure of utilisation:

- Service A and B vehicles travel on average (400 × 300) = 120,000 kilometres each year.
- Service C vehicles travel on average (600 × 300) = 180,000 kilometres each year.

46 Private medical practice

Workings

Total number of patients per year = 5 doctors × 18 patients per day × 5 days per week × 46 weeks per year = 20,700.

	Total	Adults	Children	65 years and over
		Patients		
	Total	**Adults**	**Children**	**65 years and over**
	20,700	(45%) = 9,315	(25%) = 5,175	(30%) = 6,210
Treatment				
None: 20%		1,863.0	1,035.0	1,242
Minor: 70%		6,520.5	3,622.5	4,347
Major: 10%		931.5	517.5	621

Revenue:

Adults, no treatment: 1,863 × $50 = $93,150
Adults, minor treatment: 6,520.5 × $200 = $1,304,100
Adults, major treatment: 931.5 × $600 = $558,900
Children, no treatment: 1,035 × $30 = $31,050
Children, minor treatment: 3,622.5 × $120 = $434,700
Children, major treatment: 517.5 × $280 = $144,900
65 years and over, no treatment: 1,242 × $30 = $37,260
65 years and over, minor treatment: 4,347 × $120 = $521,640
65 years and over, major treatment: 621 × $280 = $173,880.

Budgeted income statement for the year to […]

	Adults	Children	Aged 65 years and over	Total
Revenue:	**$**	**$**	**$**	**$**
No treatment	93,150	31,050	37,260	161,460
Minor treatment	1,304,100	434,700	521,640	2,260,440
Major treatment	558,900	144,900	173,880	877,680
Total revenue	1,956,150	610,650	732,780	3,299,580
Costs:				
Salaries				
Doctors (5 × $240,000)		1,200,000		
Assistants (5 × $100,000)		500,000		
Administrators (2 × $80,000)		160,000		
		1,860,000		
Bonus		93,000		
			1,953,000	
Materials costs			414,300	
Other costs			733,600	
Total costs				3,100,900
Net profit				198,680

47 Train times

	Northern Region		Southern Region	
	Inter-city services	Suburban services	Inter-city services	Suburban services
Target for completion on time	90%	95%	90%	95%
Actual % on time	82.7%	73.8%	88.3%	91.9%
% not on time, but less than 5 minutes late	7.3%	12.9%	5.6%	4.0%
% between 5 and 10 minutes late	6.0%	10.6%	2.2%	2.9%
% cancelled	3.2%	1.2%	0.1%	0.5%
	99.2%	98.5%	96.2%	99.3%
Over 10 minutes late (balance)	0.8%	1.5%	3.8%	0.7%
	100.0%	100.0%	100.0%	100.0%

Assessment of performance

Neither region has achieved its target for journeys completed on time, although Southern Region appears to be closer to achieving its targets.

Most of the late-completed journeys were completed within ten minutes of the scheduled time.

Northern Region has a fairly large proportion of cancelled trains – certainly much higher than Southern Region. However, Southern Region has a comparatively high proportion of inter-city journeys finishing over ten minutes late.

The managers of the two regions should be asked to provide a report on these aspects of performance.

48 Growth objective

Sales	
Sales growth: Year 2 compared with Year 1	20.0%
Sales growth: 1st six months of Year 2 compared with 1st six months of Year 1	28.1%
Sales growth: 2nd six months of Year 2 compared with 2nd six months of Year 1	5.0%

Sales increased by 20% in Year 2 compared with Year 1. However, the strong growth in sales occurred in the first six months of the year (28% compared with the same period in Year 1). In the second half of the year, sales growth compared with the same period in Year 1 was down to 5%. There is insufficient information to judge whether the growth in sales revenue is slowing down or coming to an end.

Net profit

There was no increase in net profit between Year 1 and Year 2. The increase in sales (20%) is offset by an increase of 30.4% in operating costs and some interest charges. In terms of annual net profit, the business is therefore not growing.

If a part-time employee is the equivalent of 50% of a full-time employee, there were 415 equivalent full time employees in Year 1 (260 + 50% × 310). There were 565 equivalent full time employees in Year 2 (318 + 50% × 494). Sales revenue per equivalent full-time employee was therefore $62,651 in Year 1 and $55,221 in Year 2. This fall in employee productivity is one reason for the failure to achieve growth in the annual net profit.

Investment

The investment in non-current assets has risen by just 5%, but the investment in working capital has doubled. The increase in net assets has been almost entirely financed by borrowing. (Presumably, this means that most of the profits earned in Year 1 have been paid in taxation or distributed as dividends to shareholders.)

It is difficult to draw definite conclusions from the limited amount of data, but management should be concerned about a 100% increase in working capital, when the increase in annual sales is only 20%. Could there be large quantities of unsold inventory as a result of the decline in sales growth in the second half of the year?
It is not clear why it was considered necessary to borrow $9,000,000 when increases in non-current assets have been only $1,300,000. It would appear that the new borrowing might be financing unnecessary working capital investment, and not investment in non-current assets for longer-term development.

On the other hand, investment in non-current assets will probably need to exceed 5% per year (by a large amount) if the company is to achieve significant long-term growth in its business.

Product range/new product sales

The data about new products is difficult to interpret, because there is no information about the total size of the product portfolio and no information about whether the new products sold well or badly.

49 Responsibility

(a) We are told that decisions about capital investment and borrowing are taken at head office. It would therefore be appropriate to look at the performance of the division over which the managing director has control – sales revenue and operating costs, but not depreciation or interest.

Sales revenue minus operating costs provides a measure of performance. This will be called 'operating profit'.

	Year 1	Year 2	Year 3	Year 4
	$000	$000	$000	$000
Sales revenue	172	646	810	1,792
Operating costs	167	620	718	1,490
Operating profit	5	26	92	302

This indicates improving performance over each year of the four-year period.

(b) Controllable performance has been improving each year. There has also been a continuing improvement in the ratio of operating profit to sales revenue.

On the basis of the information available, the managing director's view is justified.

However, senior management should assess the return that the company is obtaining on its investment in the Fenland Division. Presumably, there was an investment plan for the project, containing an estimate of the profits that the division should be expected to make.

- If sales are lower than expected, or if costs are higher than expected, the managing director of the division might be asked to give reasons why performance has not been better.
- If the size of the investment or the cost of borrowing has been more than expected, the poor performance should be attributed to the managers responsible for the investment and borrowing decisions.

50 Cross Streets Hotel

A well-designed management information system should provide relevant, accurate and timely information to all levels of management. Hence the introduction of a new system should not only allow the directors to monitor performance, but may actively help to address the issue of declining profits by providing greater feedback to tactical and operational managers.

(a) Periodic reports

The computerisation of hotel records and the online link to head office allow the latter to acquire and assimilate large volumes of data rapidly. This would permit monthly financial statements to be produced for each hotel in time for directors to review them and action their findings whilst the implications are still relevant.

The statements should comprise balance sheet, cash flow and income statement, and would enable directors to gain an overview of the effects of local management decisions and the effectiveness of corporate policy on a regional basis.

These periodic reports should include comparative data in addition to actual data. Figures could be included for budget/previous periods/industry data. Variances could be reported.

(b) Demand reports

The new system should also be capable of producing a range of reports on demand, so that senior management can assess high-risk aspects of the business by obtaining information whenever they need it.

(i) Room occupancy report

This report gives details of the proportion or percentage of a hotel's available rooms that were occupied. By using information from registration cards, it should be possible to split this figure between business and non-business users.

The incorporation of room charge-out rates into the same report would enable management to:

- assess the accuracy of revenues from room-letting
- identify if variations in regional rates have a significant impact on occupancy rates and overall profitability
- identify any trends in business/non business usage and the opportunity for differential pricing and attracting more guests.

Room rates should also be compared to a centralised master file of approved rates and discounts to ensure hotel managers are not offering rooms at below cost in an attempt to attract business.

To ensure all income from rooms let is recorded, the room occupancy report should compare rooms for which income has been recorded to a housekeeper's report giving details of the rooms cleaned.

(ii) Bad debts report

This report should highlight all debts more than (say) 60 days overdue.

Bad debts could be a major contributor to declining profits, particularly if the hotels catering for business travellers are taking block corporate bookings.

As an additional control to ensure that all reported bookings are genuine, this report should also include a comparison of revenues with a direct room cost such as laundry bills.

(iii) Restaurant sales report

This should compare total revenues from the restaurant to the number of bills raised and occupancy rate, thereby allowing the directors to ascertain if unduly preferential arrangements are being allowed by some of their hotels.

Differentiation should also be made between billings to non-residents, as this will enable attention to be focused on this separate revenue source. This is important if the restaurant is not being operated at capacity such that non-residents could be a useful source of income.

(iv) Bar sales report

Total billing should be compared as for restaurant sales, but without the division between residents and non-residents, as the latter would be difficult to obtain in view of the large number of cash transactions.

(v) Restaurant and bar inventories report

Physical control over bar and restaurant inventories is difficult to maintain and yet losses represent a potentially significant restriction on profits.

An official from head office should attend a physical count at each hotel, and this figure should then act as the benchmark for subsequent movements and be "enforced" by random spot checks.

The inventories report should compare the verified figure as adjusted for subsequent purchases and sales to occupancy rate and highlight any significant percentage variation from preceding months (indicating pilferage and misappropriation). The overall holding of inventory in each hotel should be compared to inventory turnover to ensure the former does not represent an excessive usage of working capital.

(vi) Cash availability report

Many of the bar and restaurant takings of each hotel will be in cash; as with inventories, cash is easily susceptible to misappropriation.

The head office directors will require a report that summarises the cash takings and receipts, and makes a comparison between hotels making allowances for differences in the number and type of resident (for example, business users may utilise corporate client cards rather than their own cash).

(vii) Wages report

Given that wages, often casual wages, represent a significant item of cash expenditure for hotels and one which can be directly related to revenue, a report should be produced detailing the number of waged staff per week and their wages.

This could then be compared to revenue reports to identify any significant departures from the expected relationship. This may indicate general inefficiency capable of improvement or fraud.

(c) Error/exception reports

A unique feature of computerised systems is their ability to search through large volumes of data and extract only those figures of significance to users.

These exception reports should be produced automatically to highlight matters such as:

- hotel revenue falling below budget (for example, by more than 10%)
- group cash reserves/funding requirements exceeding available limits
- hotels selling room accommodation below the approved room rate.

51 Non-financial performance measurements

Service quality

(1) The percentage of customers who take their account away in a period (the rate of 'churn')

(2) The number of complaints in a period

(3) A measure of 'satisfaction' from responses by customers to a questionnaire about the bank's services

(4) In some aspects of service, speed of response (for example, the average time to answer telephone calls from customers: these time measures can be obtained from the bank's telephone systems).

Marketing effectiveness

(1) The number of new accounts or growth rate in new accounts in the period

(2) The growth in major business activities in the period (lending, foreign exchange dealing, and so on)

(3) Market share

Personnel

(1) The rate of absenteeism in the period

(2) The amount of staff training in the period (total training days, for example)

(3) The rate of staff turnover

(4) It might be possible to identify ways of measuring staff efficiency, but this can be difficult when much of the work is non-standard or non-routine.

52 Decentralisation

(a) (i) **Responsibility accounting** is the structuring of performance reports for individual managers in a way that identifies the factors that are controllable by them and for which they are responsible. Depending on the factors under the control of the manager, responsibility accounting reports may be prepared for cost centres, revenue centres, profit centres or investment centres.

(ii) An **investment centre** is an operating division within an organisation whose manager has responsibility for both the profits of the division and the investments that it makes.

(iii) **Return on investment (ROI)** is the divisional profit divided by the capital employed within that division.

(iv) **Residual income** = Divisional income – a notional interest charge for the investment in capital investment in the division

Residual income = Divisional income – Divisional investment × cost of capital

Note: Both ROI and residual income can be used as:

- ex ante targets (planning targets) – in order to motivate divisional managers and to guide their decision-making
- ex post appraisal measures (actual performance measures) – to evaluate the divisional manager's performance.

(b) Divisions M and W

The performance of the two divisions will be evaluated using both ROI and residual income. There is no specific performance target for either division. To compare divisional performance, it is assumed that the division with the higher ROI or residual income has performed 'better'.

	Division M	Division W
ROI	20/200	410/5,000
	10%	8.2%
	$000	$000
Profit	20	410
Less: Interest on investment at 8%	(16)	(400)
Residual income	4	10

Division M has a higher ROI than Division W. However, the reason for this difference in performance may be that Division M has older non-current assets, and is reluctant to invest in new capital equipment. New investments would increase the division's profit but reduce its ROI in the short-term (because capital investment will also be higher).

Division M has a higher residual income than Division W. Therefore, in a situation where both divisional managers are motivated to accept projects that meet the firm's investment criteria (i.e. cost of capital): Division W may have been more successful in finding investments that earn a return above the cost of capital. However, the difference in residual income is only $6,000, but Division W has invested $4.8 more than Division M.

Both divisions have a positive residual income, which means that they have succeeded in investing in projects with accounting returns higher than the company's cost of capital.

A change in the company's cost of capital will only affect the residual income figure; it has no effect on the ROI. The revised residual income figures for cost of capital at 6% and 10% respectively are as follows:

	Division M	Division W
Cost of capital 6%	**$000**	**$000**
Profit	20	410
Less Interest on investment at 6%	(12)	(300)
Residual income	8	110
Cost of capital 10%		
Profit	20	410
Less Interest on investment at 10%	(20)	(500)
Residual income	0	(90)

If the cost of capital for the company is only 6%, the residual income of both Division M and Division W is higher. The larger size of the investment in Division W results in a proportionally higher RI figure.

On the other hand, if the cost of capital is raised to 10%, Division M is the better performer with a residual income of 0 compared with a negative residual income (a residual loss) of $90,000 for Division W.

53 ROI

Workings

Sales revenue

Year 2: $4.0 million × 1.05 price increase = $4.2 million

Year 3: $4.2 million × 1.05 volume increase = $4.41

Year 4: $4.41 million × 0.90 × 1.05 = $4.17 million

Year 5: $4.17 million × 0.90 × 1.05 = $3.94 million

Cost of sales

Year 1: $4.0 million × (100 – 30)% = $2.8 million

Year 2: No volume change; therefore same as in Year 1

Year 3: $2.8 million × 1.05 volume change = $2.94 million

Year 4: $2.94 million × 0.90 volume change = $2.65 million

Year 5: $2.65 million × 0.90 volume change = $2.39 million

Annual depreciation = $2 million × 20% = $400,000.

Investment

Year 1: $2.0 million

Year 2: $1.6 million

Year 3: $1.2 million

Year 4: $0.8 million

Year 5: $0.4 million

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
	$m	$m	$m	$m	$m
Sales	4.00	4.20	4.41	4.17	3.94
Cost of sales	2.80	2.80	2.94	2.65	2.39
Gross profit	1.20	1.40	1.47	1.52	1.55
Depreciation	(0.40)	(0.40)	(0.40)	(0.40)	(0.40)
Other overheads	(0.60)	(0.60)	(0.60)	(0.70)	(0.70)
Net profit	0.20	0.40	0.47	0.42	0.45
Investment	2.00	1.60	1.20	0.80	0.40
ROI (%)	10.0%	25.0%	39.2%	52.5%	112.5%

The ROI increases each year, from 10% in Year 1 to 112.5% in Year 5. This is partly because the annual profit doubles in Year 2 due to a sales price increase, and net profit then remains more or less constant in Years 2 to 5.

At the same time the net assets of the division are falling in value because no assets are replaced, and as a consequence, the ROI rises in each year.

The ability of the division to maintain stable annual profits in Years 2 to 5 is due to a combination of factors. The cost per unit of sale remains constant throughout the period, and although there is a fall in sales volume in Years 4 and 5, and an increase in other costs, these are offset by sales price increases.

54 West Division

	Sales price	Variable cost	Contribution per unit	Sales	Total contribution
	$ per unit	$ per unit	$ per unit	units	$
Product A:					
Titan brand	2.50	1.50	1.00	160,000	160,000
Unbranded	1.50	1.30	0.20	450,000	90,000
Product B:					
Titan brand	3.20	2.00	1.20	120,000	144,000
Unbranded	2.00	1.80	0.20	600,000	120,000
Product C:					
Titan brand	5.00	3.00	2.00	50,000	100,000
					614,000
				$	
Marketing costs				180,000	
Other fixed costs				375,000	
					555,000
					59,000
Notional interest: 10% × $400,000					(40,000)
Residual income					19,000

(a) ROI = 59,000/400,000 = 14.75%.

(b) Residual income (see above) = $19,000.

55 Residual

(a) ROI

Annual depreciation (straight-line) = $42,000/3 = $14,000.

Annual accounting profit = $5,000

Year	Profit	Average investment	ROI
	$	$	
1	5,000	35,000	14.3%
2	5,000	21,000	23.8%
3	5,000	7,000	71.4%
Average	5,000	21,000	23.8%

Note: Average investment, measured as the net book value of the asset, is the mid-point between $42,000 and $28,000 in Year 1, the mid-point between $28,000 and $14,000 in Year 2, and the mid-point between $14,000 and $0 in Year 3.

(b) The investment centre has been achieving a ROI in excess of 35% each year for several years. Investing in this project will therefore have the effect of bringing ROI down, although the investment is probably quite small in relation to the total size of the investment centre and its assets. The managers of the investment centre would therefore have no particular incentive to undertake the investment.

(c) Residual income

For each year, Years 1 – 3, the residual income would be as follows:

	Year 1	Year 2	Year 3
Average investment	$35,000	$21,000	$7,000
	$	$	$
Profit after depreciation	5,000	5,000	5,000
Notional interest (12% of investment)	4,200	2,520	840
Residual income	800	2,480	4,160

The residual income is positive in each of the three years, although it increases each year as the value of the investment declines.

If the performance of the investment centre is measured by residual income, its managers would be willing to undertake the investment because it will improve the divisional performance by increasing the residual income.

56 Two divisions

(a) An optimal transfer price (or range of transfer prices) is a price for an internally-transferred item at which:

- the selling division will want to sell units to the other profit centre, because this will add to its divisional profit
- the buying division will want to buy units from the other profit centre, because this will add to its divisional profit
- the internal transfer will be in the best interests of the entity as a whole, because it will help to maximise its total profit.

(b) When Division X has spare capacity, its only cost in making and selling extra units of Product B is the variable cost per unit of production, \$48. Division Y can buy the product from an external supplier for \$55.

It follows that a transfer that is higher than \$48 but lower than \$55, for additional units of production, will benefit both profit centres as well as the company as a whole. (It is in the best interests of the company to make the units in Division X at a cost of \$48 than to buy them externally for \$55.)

(c) When Division X is operating at full capacity and has unsatisfied external demand for Product A, it has an opportunity cost if it makes Product B for transfer to Division Y. Product A earns a contribution of \$16 per unit (\$62 – \$46). The minimum transfer price that it would require for Product B is:

	\$
Variable cost of production of Product B	48
Opportunity cost: lost contribution from sale of Product A	16
Minimum transfer price to satisfy Division X management	64

Division Y can buy the product from an external supplier for \$55, and will not want to buy from Division X at a price of \$64. The maximum price it will want to pay is \$55.

The company as a whole will benefit if Division X makes and sells Product A.

- It makes a contribution of \$16 from each unit of Product A.
- If Division X were to make and sell Product B, the company would benefit by only \$7. This is the difference in the cost of making the product in Division X (\$48) and the cost of buying it externally (\$55).

The same quantity of limited resources (direct labour in Division X) is needed for each product, therefore the company benefits by \$9 (\$16 – \$7) from making units of Product A instead of units of Product B.

On the basis of this information, the transfer price for Product X should be \$64 as long as there is unsatisfied demand for Product A. At this price, there will be no transfers of Product B.

57 Training company

(a) If the Liverpool centre has spare capacity, it will be in the best interest of the company for the London centre to use Liverpool trainers, at a variable cost of £450 per day including travel and accommodation, instead of hiring external trainers at a cost of £1,200.

Since the Liverpool centre will have to pay £450 per trainer day, any transfer price per day/daily fee in excess of £450 would add to its profit.

Since the London centre can obtain external trainers for £1,200 per day, any transfer price below this amount would add to its profit.

An appropriate transfer price would therefore be a price anywhere above £450 per day and below £1,200 per day.

(b) If the Liverpool centre is operating at full capacity and is charging clients £750 per trainer day, there will be an opportunity cost of sending its trainers to work for the London centre. The opportunity cost is the contribution forgone by not using the trainers locally in Liverpool. Assuming that the variable cost of using trainers in Liverpool would be £200 per day, the opportunity cost is £550 (£750 – £200).

The minimum transfer price that the manager of the Liverpool centre would want is:

	£
Variable cost of trainer day	200
Travel and accommodation	250
Opportunity cost: lost contribution	550
Minimum transfer price	1,000

The maximum price that the London centre would be willing to pay is £1,200, which is the cost of using an external trainer.

The company should encourage the use of Liverpool trainers by the London centre, because this will add to the total company profit.

The optimal transfer price is above £1,000 per day, so that the Liverpool centre will benefit from sending trainers to London, but below £1,200 so that the London centre will also benefit.

A transfer price of £1,000 per day might be agreed.

(c) If the Liverpool centre is operating at full capacity and is charging clients £1,100 per trainer day, the opportunity cost of sending its trainers to work for the London centre is £900 (£1,100 – £200).

The minimum transfer price that the manager of the Liverpool centre would want is:

	£
Variable cost of trainer day	200
Travel and accommodation	250
Opportunity cost: lost contribution	900
Minimum transfer price	1,350

The maximum price that the London centre would be willing to pay is £1,200, which is the cost of using an external trainer.

It would be in the best interests of the company as a whole to use the Liverpool trainers to work for Liverpool clients, earning a contribution of £900 per day, rather than use them in London to save net costs of £750 per day (£1,200 – £200 – £250).

The transfer price should be set at £1,350 per trainer day. At this rate, the London centre will use external trainers, and all the Liverpool trainers will be used in Liverpool.

58 Shadow price

(a) The shadow price of the special chemical is the amount by which total contribution would be reduced (or increased) if one unit less (or more) of the chemical were available.

1 kilogram = 1,000 grams; therefore one kilogram of special chemical will produce 100 tablets (1,000/10 grams per tablet).

Shadow price of the chemical	**$**
Sales value of 100 tablets (× $10)	1,000
Further processing costs in B (× $2)	200
	800
Variable cost of making the chemical in A	500
Shadow price per kilogram of chemical	300

(b) The special chemical does not have an intermediate market.

- The ideal transfer price for A is therefore any price above the variable cost of making the chemical, which is $500 per kilogram.
- The ideal transfer price for B is anything below the net increase in contribution from processing a kilogram of the chemical. This is $1,000 – $200 = $800 per kilogram.
- There is no single ideal price. Any price in the range above $500 and below $800 should make the managers of both profit centres want to produce up to the capacity in division A.
- A transfer price in the middle of the range, say $650, might be agreed.

(c) The transfer price is needed to share the profit from selling the tablets between divisions A and B. It is an internally negotiated price. Changing the price will not affect the total profit for the company as a whole, provided that division A produces the chemical up to its production capacity.

The transfer price itself should not be used as a basis for judging performance. Having agreed a transfer price, key financial measures of performance will be control over costs for division A and control over costs and the selling price for tablets for division B.

(The divisions are profit centres, and so the performance of the divisional managers should not be assessed on the basis of ROI or residual income.)

59 Bricks

(a) Profit statements

(i) Operating at 80% capacity

	Transfer price $200			Transfer price $180		
	Group X	Group Y	Total	Group X	Group Y	Total
Sales:						
External	180	240	420	180	240	420
Transfers	120	-	0	108	-	0
Total	300	240	420	288	240	420
Costs						
Transfers	-	(120)	0	-	(108)	0
Variable	(112)	(36)	(148)	(112)	(36)	(148)
Fixed	(100)	(40)	(140)	(100)	(40)	(140)
Total	(212)	(196)	(288)	(212)	(184)	(288)
Profit	88	44	132	76	56	132

(ii) Operating at 100% capacity

	Transfer price $200			Transfer price $180		
	Group X	Group Y	Total	Group X	Group Y	Total
Sales:						
External	180	320	500	180	320	500
Transfers	200	-	0	180	-	0
Total	380	320	500	360	320	500
Costs						
Transfers	-	(200)	0	-	(180)	0
Variable	(140)	(60)	(200)	(140)	(60)	(200)
Fixed	(100)	(40)	(140)	(100)	(40)	(140)
Total	(240)	(300)	(340)	(240)	(280)	(340)
Profit	140	20	160	120	40	160

(b) The effect of a change in the transfer price from \$200 to \$180 will result in lower profit for Group X and higher profit for Group Y, but the total profit for the company as a whole will be unaffected.

A reduction in the transfer price to \$180 (or possibly lower) is recommended, because this is the price at which Group Y can buy the materials externally. At any price above \$180, Group Y will want to buy externally, and this would not be in the interests of the company as a whole.

Significantly, at a transfer price of both \$200 and \$180, Division Y would suffer a fall in its divisional profit if it reduced the selling price of bricks to \$0.32 and increased capacity by 400,000 bricks each month. A reduction in price would be in the best interests of the company as a whole, because total profit would rise from \$132,000 per month to \$160,000.

(c) Ignoring the transfer price, the effect on Division Y of reducing the sale price of bricks to \$0.32 would be to increase external sales by \$80,000 and variable costs in Division Y by \$24,000 (400 tonnes × \$60). Cash flows would therefore improve by \$56,000 per month. To persuade Division Y to take the extra 400 tonnes, the transfer price should not exceed \$140 (\$56,000/400). This is below the current external market price, although there is strong price competition in the market.

The transfer price for Division X should not be less than the variable cost of production in Division X, which is \$70 per tonne.

However, if the transfer price is reduced to \$140 per tonne or less, Division X might try to sell more materials in the external market, by reducing the selling price.

It would appear that although the ideal transfer price might be \$140 or below, this will not be easily negotiated between the group managers. An imposed settlement may be necessary. Intervention by head office might be needed to impose a transfer price, and require Division Y to reduce its sales price to \$0.32.

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